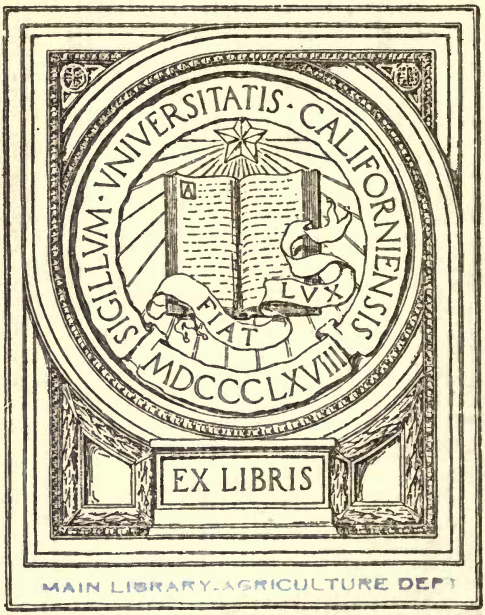
AMERICAN

SILK GROWERS' GUIDE.



Messrs Hovey & Co

With the Respects of the Author

Jan 1. 1839

THE

AMERICAN

SILK GROWER'S GUIDE;

OR THE

ART OF RAISING

THE

MULBERRY AND SILK,

AND THE SYSTEM OF

SUCCESSIVE CROPS IN EACH SEASON.

SECOND EDITION, ENLARGED AND IMPROVED.

BY WILLIAM KENRICK.

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PREFACE

TO THE SECOND EDITION.

THE favorable reception by the public, of the first and a large edition of this work, has induced me to offer a new volume, with extensive additions and improvements from the new and abundant materials which have come to hand.

Particularly have I noticed many of the improvements which have been adopted in some of the silk establishments and manufactories which have so lately arisen into existence in the various sections of our country, as well also as those very important improvements which have so recently been adopted in France. For here chiefly it was, and with reason, that I expected to find, exemplified in practice, some of those improvements, the most signal and decisive, of the latest day.

The system of raising silk, which I have more especially recommended for America, is, in many respects, another and separate system from that which is usually practised in the less favored sections of Europe. It is the system particularly adapted to our own highly favored climate—to our more serene atmosphere, and almost perpetual sunshine during summer, and to the peculiar requirements of our people.

Silk is believed to be eminently adapted to the soil and climate of every division of the Great Republic. Our serene atmosphere is peculiarly favorable to its growth, and the prolonged and vigorous state of vegetation during our summers. The genial climate for silk is ours, and the highly favored soil of one whole continent of the great western world, which, by an especial providence, with the exception only of Mexico, has fallen to our share, and is ours exclusively.

The annual imports of Britain are four million pounds of raw and thrown silk, at a cost of about £1 5*s.* sterling ($5 55) per pound. But the annual value of the silk manufactured in England is £14,000,000 sterling, or more than $62,000,000. The manufactures and exports of France also, as I have elsewhere stated, are enormous. The value of silks imported into the United States, in the year ending in September, 1836, was $22,862,177; besides more than $6,000,000 in value, of goods composed of part silk, and part cotton or worsted;—but this was a year of excessive importation, and is not stated as a just average. But the value of silks imported into the United States during the previous year, or the year ending in September, 1835, amounted to $16,497,980; this being *the original or first cost in the foreign country.* Neither the articles of raw silk, nor any of those numerous and elegant fabrics, which are composed of part silk and part

cotton, or of silk and worsted, are included in this amount. During this period, only $486,562 worth of this great amount was exported; leaving $16,111,418 for consumption. But the actual amount of silks, without mixture, which are consumed by the American people, or *the whole cost at retail to the actual consumer*, may be fairly estimated at more than $22,000,000 for the year. It must be even greater in this day. And the demand, which is now so great, is continually increasing. Not half this amount of silk was consumed eight years ago; and since 1821, and during seventeen years, the amount of silks consumed has doubled twice.

Asia, and the country from whence originally we derived the silk-worm, has also given to America the new plant, so surpassing in beauty, and which, from the superior nutritive quality of the leaf, and the promptitude with which it is renewed, will afford the abundant and continued succession of nourishment for a double harvest—a plant, which, from the extraordinary quality and size of the leaf, will give to this new and great interest a new and decisive impulse, by producing the most decided saving of time in the cultivation, and an all-important saving of labor in gathering the food. In this reference I may moreover include that other new Chinese mulberry, so lately introduced from China, and described at page 30; and which is also of high character, and eminently splendid. Many trees of this variety, received by John P. Cushing, Esq., of Belmont, Watertown, direct from his Chinese friend at Canton, have been liberally disseminated by him.

Our advantages are indeed very great; to be duly appreciated they must be estimated singly and individually. How much greater and more striking will they then appear, if considered collectively. Our innumerable rivers and rapid streams, our immense forests and mines, the exhaustless treasures of fuel and of flame, the combined elements of water, earth, and of fire, offer resources of mighty power, unknown and immeasurable, and willing aids in abridging the labors of man.

History will record to endless remembrance, the names of those illustrious individuals who have persevered as the faithful guides and pioneers in this great work—those who, by their example or writings, have served as lights to illumine our way, and to cheer us through the long, dark and dreary night.

The decisive impulse is already given—already are its mighty influences extending throughout our country, far and wide. The Americans are awake! Hope dawns auspicious—the day and its brightness will be ours. Endowed, as are our people, with fortitude, with energy, and with intellectual resources unsurpassed—is there one American who can doubt?

Most of all, might I desire to be useful, by aiding in the introduction of a culture, which may make rich the people, even of the less fertile districts, and open to our country the resources of unceasing wealth. WILLIAM KENRICK.

Nonantum Hill, Newton, Mass., 1839.

INTRODUCTION.

CHINESE MODES OF MANAGEMENT. IMPROVED MODES ADOPTED IN FRANCE.

According to the authority of the Chinese treatises, and also the high authority of M. Camille Beauvais, while the French have usually lost near fifty in one hundred of their silk-worms, the Chinese hardly lose one in a hundred. This may, in part, be ascribed to their practice of rejecting in the first instance, and invariably, those few worms that hatch first, and also to the great attention they pay to the insects; but principally, and most of all, their great success is ascribed to their subsequent treatment of the insects, and particularly to their modes contrived for the purposes of ventilation. By these modes, the exterior air is made to enter the apartment for the silk-worms, by numerous tubes on a line level with the floor. When these tubes are opened, an impure atmosphere is expelled upwards, and escapes through various openings in the ceiling or roof, and the air of the rooms is cooled and refreshed. When it is desired to elevate the temperature, these openings are closed. When the silk-worms are forming their cocoons, the temperature is always kept elevated. If the warmth of the atmosphere is insufficient, small chafing dishes of coals are occasionally placed beneath two large hurdles, which are united at top and stand inclining.

At the Government establishment, or experimental silk farm, near Montgeron, in the north of France, M. Camille Beauvais, the superintendent, has adopted, with signal success, the more complete system of ventilation and of warming the apartments, invented by M. D'Arcet. By this mode, the air of a whole establishment is speedily warmed by means of a furnace in the cellar, the heated air being conveyed beneath by flues, is admitted upwards to the apartment by numerous openings, which are distributed in the floor; the cold and impure air, being expelled upwards, escapes by numerous openings in the roof. In most of our cities, at this day, many private houses, and a great proportion of the public houses and churches are warmed in this way; an equal temperature is thus produced in a mode the most perfect and economical hitherto devised. In like manner, as I conceive, a pure, cool and refreshing atmosphere may also, at any time, be

forced into an apartment from beneath the floor, through numerous openings by strong currents of air artificially produced, which would, in a few moments of time, expel, through numerous openings in the roof, the whole interior and impure heated atmosphere of a vast apartment of silk-worms. Thus it is, that in some parts of India, the apartments of the opulent are refreshed by cool breezes artificially produced, a man standing at the door with a vast fan.

Already at this establishment, and by his extraordinary management, has M. Camille Beauvais succeeded in producing thirteen pounds of silk from the same number of silk-worms which in France usually produce but five pounds, and in Italy seven and a half pounds, and in India twenty pounds ; and even in that cold climate, he expects soon to be able to produce an equal number of pounds.

Through the politeness of Edward S. Rand, Esq., of Newburyport, I have been favored with the loan of a splendid Chinese quarto volume, the property of Capt. David Wood, of that town, and brought out by him from China. It is composed of twenty-eight superb colored engravings on rice paper, which represent every part of the process of cultivating the Mulberry, and of raising silk, from the first planting of the mulberry, until the reeled silk is wound off from the reel by hand, upon the distaff.

In those engravings, the plants are represented as kept low for the convenience of gathering the leaves; or, rising up in spring, usually several stalks from the same root. The gathering of the leaves commences in the first year. The trees being successively stripped of their leaves during summer, in autumn the shrubs, thus defoliated, are cut down for the production of a new, luxuriant and future crop of leaves. This is in perfect conformity to the statements of Mr. Cushing, who resided in China many years. In gathering the leaves, I observe that the footstalks are always left, and also a few small leaves on the summit, until the last gathering of the season takes place, and previous to the plants being cut down in autumn.

The ninth Plate, is a representation of children and females gathering the leaves in the manner above described, from the young trees of a few feet in height, and of the first year's growth.

The tenth Plate, is a representation of the plantation thus stripped of its verdure ; it shews also the modes and process of the cultivation.

The eleventh Plate, is a representation of the second gathering of the leaves of the season, by females, from the trees, which are now of a more advanced growth.

The twelfth Plate, is a representation of the operation of cutting down the plants, to near the surface of the earth, after they have been completely defoliated for the last time of the season.

Other modes of management in China are given in detail at p. 58.

SILK GROWER'S GUIDE.

SECTION I.

HISTORY OF SILK: ITS ANTIQUITY AND COMMERCE.

Silk, or the splendid material produced by the silk-worm, was first known in ancient *Ser* or *Serica*, in China. It was there first discovered in its own native forests of the mulberry-tree. In that country it was called *Se*, and by transition it was called *Ser* by the Greeks, and *Sericum* by the Romans; and hence by the different nations of Italy, of France, and of England, it is variously called *Seta*, *Soie*, and *Silk* at the present day. Anciently also, it was called *Bombykya*, or *Bombycina*, from *Bombyx*, a caterpillar which spins a web.

The silk-worm, or *Bombyx mori*, is a precious insect, which is thus denominated from *morus*, the plant on which it feeds; otherwise, and anciently, the Bombyx *Assyrian* or *Syrian*, improperly so called, since the country of the *Seres* or *Chinese*, was another country, the most remote, and bounded on other shores; many a nation and far distant country intervening.

The cultivation of silk commenced in China 700 years before Abraham, and 2700 years before Christ,

The Emperor Houng-ti, "the Emperor of the Earth," who reigned over China more than 100 years, and whose name is rendered immortal for his noble and useful deeds—he who taught the Chinese to construct houses, ships, mills, carts, and other works of usefulness—he, also, persuaded his first consort, Si-ling-chi, to bestow her attention on the silk-worms, it being his earnest desire that his Empress also might contribute to the welfare of the empire. Aided by the women of her household, the Empress Si-ling-chi gathered the silk-worms from the trees, and introduced them to the imperial apartments. Thus sheltered and protected, and abundantly supplied with the leaves of the mulberry, they yielded silk superior in quality to that produced in the forests. She also taught them its manufacture, and to embroider.

Silk and its manufacture, and the weaving, continued to be the principal occupation of the succeeding Empresses; apartments being especially appropriated to this purpose, in the Imperial Palace; and soon, from the highest rank of females, it became the occupation of all ranks in China; and ere long, the Emperor, the learned class, the princes, the mandarins, and courtiers, and all the rich, were attired in the splendid fabrics of silk, until finally, silk became the great and inexhaustible resource of the wealth of China.

From China it was exported to India, to Persia, to Arabia, and indeed to the whole of Asia. The caravans of Serica performed long journeys of 243 days, from the far coasts of China to those of Syria. Silk was also re-woven and manufactured at a very ancient date, in the island of *Kos*, situated in the Archipelago, from the substantial fabrics which were received from Seres. It was here that Pamphila first invented and taught her nymphs to unravel, and with her loom to recompose from the precious material, the thin transparent gauze and the other fabrics of an equally extended nature.

The expeditions of Alexander to Persia, and to India,

first introduced the knowledge of silk to the Grecians, 350 years before Christ, and with the increase of wealth and luxury in the Grecian court, the demand of silks prodigiously augmented. Persia engrossed for a time the trade of Greece, and became rich in the commerce of silk, which they procured from China. The ancient Phœnicians also engaged in the traffic of silk, and finally carried it to the east of Europe. But for a long time after, even those who brought it to Europe knew not what it was, nor how it was produced, nor where situated was the original country of Serica from whence it came.

Ser or Serica was called Sereinda, a name evidently composed of Seres and of Indi, the names of two distinct and separate countries which the ancients had thus confounded; even as the name of *India* has been, and still is, often indiscriminately applied to all the countries of the whole east of Asia, at the present day.

Ammianus Marcellinus, the celebrated historian, has described the Seres as a sedate and gentle people, living in perpetual peace with the neighboring nations, and therefore exempted alike from the calamities and the alarms of war: with no occasion for offensive weapons or even the knowledge of their use. Blessed with a soil the most fertile, and a climate the most delightful and salubrious, they are represented "as passing their happy days in the most perfect tranquillity and delightful leisure, amid shady groves, fanned by gentle breezes, and producing fleeces of downy wool, which, after being sprinkled with water, is combed off in the finest threads and woven into *sericum*."

This fable, which undoubtedly served for ages to deceive the nations, is supposed to have been the invention of the Seres themselves, that they might appear to the wondering world as a *peculiar people*, on whom blessings were profusely showered down from heaven, in which no other nation could expect to participate.

At Rome, and so late as A. D. 280, a silk attire of

purple, was accounted by an Emperor as a luxury too expensive even for an Empress, and that Empress his wife, Severa; its value being equal to that of gold, by weight. Others there were at Rome, and enough even at that day, who were by no means thus scrupulous in regard to price. But it was not till long after the seat of the Roman Empire had been transferred to Byzantium or Constantinople, that the distinct and more perfect knowledge of the nature and origin of silk became known, and the mystery of the long sought "*golden fleece*" was revealed to Europe.

In the sixth century, two monks arrived at the court of the Emperor Justinian, at Constantinople, from a missionary expedition to China. They had brought with them the seeds of the mulberry, and communicated to him the discovery of the mode of rearing the silk-worms. And although the exportation of the insects from China was forbidden, on pain of death, yet by the liberal promises and persuasions of Justinian, they undertook a new expedition, and at length they returned through Boukharia and Persia to Constantinople, in 555, with the eggs of the precious insect concealed in the hollow of their canes or pilgrims' staves, which they had obtained in *the far and still more distant country*. Until this time, the extensive manufactures of the Phœnician cities of Tyre and Berytus had received their whole supplies of raw silk through Persia from China. Even to the days of Justinian, according to ancient historians, no person at Constantinople knew to a certainty that silk was the production of an insect. It was generally supposed to be produced from the bark or leaves of trees, or growing like the finest hair from their branches. A new era now commenced.

In Greece, the culture and manufacture of silk soon overspread the country; the noblest families themselves aided by their example. The people of Thebes and Athens, from the time of Justinian, cultivated and manufactured silk for 400 years. And the Venetians in the height of their

prosperity and commercial glory, carried supplies of silk from Greece to the whole west of Europe. On the downfall of the Roman Empire, Arabia became the seat and centre of science, of arts, and of civilization. The establishment of the Turkish power in Asia about the middle of the 6th century, and the subsequent wars, caused great interruption to the caravan trade between China and Persia. And after the conquests of Mohammed II. the Saracens or Arabians planted the mulberry and encouraged the culture of silk everywhere, throughout their dominions, both on the islands and on all the shores of the Mediterranean. Silk and the mulberry were introduced to Spain and Portugal by the Arabians or Saracens, on their conquest of those countries in 711. Spain is also indebted to their enlightened conquerors, for their political redemption from barbarism. Those wise sovereigns, the great Caliph Haroun al Raschid, and his immediate successor, introduced as axioms of policy, the arts of civilization, as essential to the welfare of a nation—the practice of *agriculture*, *commerce* and *industry*, being especially inculcated by the Koran itself; thus elevated to *virtues*, they are ranked with the *good deeds of the believer*.

From Greece the cultivation of silk was introduced to Sicily and Naples. Roger, king of Sicily, on his invasion of Greece in 1146, introduced by compulsion many silk weavers and manufacturers, which he carried to Palermo. In 20 years, the manufactures of Sicily became famous, being adorned with various colors and figures, interwoven with gold, and embellished with pearls. Here it long mysteriously remained, and it was not till 1540 that it had extended to Piedmont and indeed to all Italy. So extensive is its cultivation at the present day throughout Italy, that according to Count Dandolo, two thirds of their whole exports to all countries consist of silk. Its first introduction to France was in 1494; but no very important result succeeded, until, in 1564, Traucat, a common gardener of Nismes,

established the first foundation of a nursery of White Mulberry trees, with an effect so successful, that, from this source, as from a centre, the cultivation extended within a few years over the whole of the southern provinces of France. But its final and more complete establishment in France in 1603, is due to Henry IV., who encouraged by every mode the formation of nurseries, and the manufactures of silk, even in the northern, as well as middle provinces of the kingdom, and whose name is held in perpetual remembrance for his noble deeds of goodness and works of usefulness. Olivier de Serres shares equally with him the glory of the effectual work, which was at first opposed even by Sully, from mistake and misapprehension. Colbert, in a succeeding age, continued his fostering care. Both Colbert and his illustrious predecessor, by bounties judiciously bestowed, caused both the mulberry tree and its culture to strike deep and permanent root in the soil of France. Once established, it has stood, unmoved by every revolution and storm :—unprotected and alone, while all things else have fallen, this important industry has flourished, until finally, silk and its manufacture has become one of the most productive sources of the wealth and the power of France.

The whole value of the silks manufactured annually in France in 1835, amounted by computation, to 140, 000,000 francs, and it was estimated in Europe, that in that year, silks to the amount of 50,000,000 francs were exported from that country to the United States alone.

Yet in France, although they raise so much silk, they still import annually, to the amount of 43,000,000 francs of raw silk, or nearly one third of all they consume, for the supply of their manufactures.

In England, the climate, from its humidity or other causes, is found to be unsuited to its growth ; for this reason alone, the trials to raise it there have failed. Yet from 1821 to 1828, according to a late and authentic work on the silk trade, they imported of raw silk,

24,157,568 lbs.; worth $120,787,580. Of this amount $59,881,283 came from Italy alone.

At the present day, the silks which were consumed in Great Britain alone, so late as 1835, amounted to the enormous sum of $28,282,582 annually, at the wholesale prices, besides the whole amount of all they exported.

The sudden and extraordinary extension of the silk manufactures, both in France and in England, during the last 18 years, has been mainly ascribed to the machine invented in France by M. Jacquard; and the powerful impulse thus given, has been assigned to the *Jacquard Loom.* This loom is stated to perform all those labors which had heretofore been exclusively confined to the most skilful hands, with important economy of time, and of labor in the preliminary steps, and is so decidedly superior to all other looms, for all the curious varieties of figure-silk weaving, that it has superseded them all, both throughout France and England.

Yet in our own country, so highly favored in all respects by nature, the successful introduction of the silk culture, is mainly due to individual exertion. One day, the cultivation of the mulberry, and the growth and manufacture of silk, in the United States, will become a very important resource of wealth to the nation. Unsupported and alone, the work has wonderfully begun, and is now taking deep and permanent root in the soil of our country.

I have before stated, that, according to the report of the Secretary of the Treasury, the value of silks imported into the United States during the year ending 30th September, 1835, amounted to $16,597,980: this being the original or first cost in the foreign countries. During this period, only $486,562 worth of this great amount was exported: and the actual cost of the above to the American people, or the *whole retail cost to the actual consumer*, may be estimated at more than $22,000,000 for the year. Most of all this was imported from Italy, Switzerland and from France. Formerly,

half our imports were from China. Yet neither the articles of raw silk, nor any of those numerous, substantial, and elegant fabrics, which are composed of part silk, and part cotton, or mixtures of silk and worsted, are included in the above amount. In no year previous to 1821, had the annual amount consumed arisen to *one fourth* of what it was in 1835. But in no year previous to 1830 had the annual consumption arisen to *one half* this amount; the increase during 15 years being fourfold.

In the year ending September 1836, the importations of silk amounted to $22,000,000 at the first cost in foreign countries; and the imports of those fabrics composed of part silk and cotton, and part silk and worsted, amounted to $6,000,000 more in that same year; but this was a year of excessive importations and is not stated as the average.

Those resources, the millions we now annually expend for silks, the productions of foreign industry and of foreign policy; those vast sums should be preserved to our own citizens, and a great and general interest encouraged—an interest so adapted, as an occupation for the feeble, and a resource for the poor, and to awaken to habits of industry and of virtue the rising generation. Thus instructed and educated, they will be enabled to contribute their share to the public happiness and prosperity, and to add to the resources and wealth of the country.

The enterprise, the fertile invention, the noble efforts of individual exertion, have already accomplished much; but much yet remains to be done. That industry, that portion which, unawakened is now lost, being alone more than sufficient to accomplish all—more than sufficient to recover again those very considerable sums, the millions so lavishly expended, with interest an hundred fold.

By those unceasing toils, and mighty efforts, and matchless labors, for which our people are so distinguished; the millions thus recovered, will not only be their just reward, but will add to the substantial wealth of the nation, and to the glory of the whole republic.

SECTION II.

HISTORY OF THE SILK-WORM.

The silk-worm or *Bombyx mori*, is a caterpillar; its body formed of twelve membranous rings, which support the legs, which are sixteen in number and in pairs. Six of these are in front and inflexible, and situated beneath the three first rings, and are each covered with a scale. The other ten are flexible, and membranous, their positions beneath the rings; these are called climbers or holders, and are provided with sharp hooks or claws, to aid in climbing. The head has a horny covering, like a scale; the jaws are very strong, the teeth sharp, serrated, or indented like a saw. The mouth is vertical and peculiar, and not horizontal as in most other beings; two broad objects in its forehead, which might be mistaken for eyes, are but bones of the skull. The eyes are small, fourteen in number, seven on each side of the head and near the mouth. The organs of respiration are eighteen in number; equi-distant, and situated along the body are the holes or openings, nine on each side, which serve for breathing.

The substance of which the silk is composed is a liquid transparent gum, of a fine yellow color, and is contained in two separate sacks, of slender dimensions. Each of these vessels is about ten inches in length, and wound in the stomach in spiral folds: near the jaws two ducts convey the silken fluid; these uniting in one serve to compose the silken thread, which is usually from 400 to 1200 feet in length.

The eggs of the silk-worm are of a dark lilac or slate color. The silk-worms are at first black and extremely small; as they advance in age and size, they cast off their outer covering or skin, usually from three to four times at different periods, according to the variety. These successive changes are called *moultings;* and the

times intervening are termed *ages*. In a colder tem perature, the duration of these several periods is prolonged ; but in a warm climate, the period or season of the first moulting, which terminates the first age, usually occurs on the fourth or fifth day of its existence; the second on the eighth or ninth day; the third on the thirteenth or fourteenth day; and the last on the twenty-second day. At each of these critical periods, the silk-worms remain in a torpid state, eating little or absolutely nothing for a day or more. At the end of about ten days more from the last period, or in about thirty-two days from the beginning, the insect, now fully grown, is about three inches and one third in length, transparent, of a yellowish white or pearl color. Having now completed their fifth or last age, they eat no more, but ascend to the leaves or brushwood, which are placed for the purpose, and commence the formation of the cocoons; and in the construction of these, the insect works busily and incessantly night and day, during four days. The labor finished, the insect in the centre becomes transformed to the chrysalis state.

The vital functions of the silk-worm are accelerated by warmth and the time occupied in passing through the various mutations, is hastened, not only by the increased temperature, but materially by the degree of attention which is bestowed on the insects. In Madras, according to Dr. Anderson, and where the climate is very warm, the silk-worm passes through all its evolutions in 22 days. Here then is a saving of time as well as labor, but none in regard to food, as it is admitted that the silk-worms consume the same amount of food to produce the same weight of cocoons, be the term of their lives of a longer or shorter duration.

The cocoon is usually an inch and a third in length, of an oval form; the color yellow, or straw, or pure white. The outer covering is like finest wool, and is called flos, and is easily detached; this being removed, the end of a thread is discovered, of extreme fineness.

After an interval of from 15 to 20 days repose, the moth ejects from its mouth a liquor, which moistens the gum and dissolves the adhesiveness of the texture of the ball, and by frequent motions of its head, it loosens and forces aside the filaments, without sundering a single silken thread, until it reappears, transformed to a large butterfly, of a greyish white color, with four wings, two eyes, and two black feathery horns or plumes. Unshrouded, in this its last and perfect form, both male and female, they come forth to the light of day: from this time they take no visible food to the day of their death.

They commence laying their eggs in twenty-four or thirty-six hours after leaving the cocoon. Each female usually lays four hundred eggs, which firmly adhere to the paper, on which they are arranged in a handsome and circular form. In a few days after, their multifarious labors being ended, the insect dies.

The silkworm remains in the chrysalis state a length of time corresponding with the temperature of the climate. In England they remain 30 days. In France 21, in Spain and Italy 18 or 20; in the United States about the same, and in India but 11 days.

The silk-worm, like other caterpillars, is a cold-blooded insect, its temperature that of the atmosphere in which it breathes. Sudden changes from cold to heat are highly injurious; yet it has been found that the silk-worm is capable of enduring a great degree of heat if uniformly maintained. Such a degree they must at times endure in their own native forests, not only of light, but also of heat, with no shelter from the scorching sun but the shadow of a leaf. Yet in no case is a due degree of warmth more needful, than while the insect is forming the cocoon. If at any time while they are performing this most important labor, they are permitted to suffer from cold, they cease from their labors, and remain inactive, or move but slowly, as may be discerned while the cocoons are yet transparent. It has

been proved, on dissection of the silk-worms which thus suffer and become torpid through cold, that the glutinous matter in their silk reservoirs had become so congealed and tenacious, from cold, as to resemble strong tendons; which sufficiently accounted for the inability of the insect to draw forth the silken filament. Yet no sooner is the temperature increased, than they will resume their labors with increased activity; but will again desist, if exposed again to cold. If neglected at this critical period, they assume in due time, the chrysalis form, but for want of sufficient strength, leave incomplete their silken tomb.

Many persons have erroneously imagined, that light is injurious to the silk-worms: but the very reverse of a belief so contrary to nature, is evidently true. In its native state, it is of course habituated to the most perfect light. Indeed a due proportion of the reviving light of day has been found essentially necessary to its perfect health. In the perfect light of day, the leaves of the mulberry and other trees exhale vital air, or that pure, ætherial substance which, by being inhaled, gives life and heat to the animal system, and fuel to flame; while in the darkness they evolve mephitic air, which is destructive and incapable of affording nourishment either to life or to flame.

Although the silk-worm will endure a great degree of heat, yet when this heat is combined with excessive moisture, the effect appears to be at least as deleterious to the insects as mephitic air. If a silk-worm be confined in a close vessel surcharged with moisture, and heated to 88 deg. or 90 deg., it will soon reject food, and shew strong symptoms of distress. The muscles will soften, and evaporation will become obstructed: the power of contraction which resides in the skin, and which governs the secretions which are indispensably necessary to its existence, will cease, and it will shortly perish: while a warm-blooded animal, if sufficiently supplied with pure atmospheric air, will endure an equal

degree of heat combined with an equal degree of moisture, with but little inconvenience.

But if a silk-worm be introduced into a jar charged with carbonic acid gas which would cause a bird or any other warm-blooded animal to die instantly, although the worm will soon exhibit signs of suffering, yet it will live from ten to twenty minutes, and, on being withdrawn from the receiver in due time, it will exhibit no signs of injury, but be apparently as healthy as before. The silk-worm will also live for some minutes in water, especially in the early stages of its existence; it seems indeed to possess the faculty of disengaging vital air from the water, and even when apparently dead, it will revive on being taken out again. But if, instead of being plunged into water or into mephitic air, its eighteen breathing holes be closed up with grease, it dies instantly.

Some have supposed that noise disconcerts them; but this appears to be a mistake, as has been proved in France, by the Abbe Rosier and M. Thome, who made the experiment of discharging pistols in the apartments where the silk-worms were kept, which they regarded not. Neither are they in the least affected or annoyed by the barking of dogs, or by concerts of music, or the noise and bustle of cities, even while spinning, or when about ascending, preparatory to this last work. Thunder, indeed, has sometimes the effect of producing a temporary suspension of their labors, while the insect is completely immersed and insulated in its silken cell; or, at other times, of causing some of the most feeble to fall; but this is rather to be ascribed to the sudden shock or concussion which is produced upon the earth and atmosphere, by a heavy clap of thunder: also to the extreme lassitude and sense of oppression, which the silk-worms must necessarily suffer, filled as they are with a fluid as highly electrical as silk: and to this, being also superadded, an atmosphere, overcharged with the electrical elements, until, by the silent operation of

the conductor, or by loud and spontaneous bursts, the warring elements have fully discharged the arsenal of their fiery wrath, and the equilibrium is restored.

SECTION III.

VARIETIES OF SILK-WORMS.

1. Besides the kind of silk-worm already described, there is a kind, one of the most beautiful I have ever seen; these are of a pure white, and their cocoons are also very beautiful, and of a snowy whiteness. Possibly this may be the identical China silk-worm, which produces silk of a superior quality, and which, according to one account, was brought to France about thirty years ago.

2. There is a variety of silk-worm which was introduced from China into France about 50 years ago, but which has not been much cultivated until the last 30 years. These are much prized by Count Dandolo, who has raised many of this kind, and prefers them to all others. They cast their skins but thrice, and produce silk of a white color. He recommends to make choice constantly only of the very finest and whitest cocoons to prevent a degeneracy.

3. There is a variety of silk-worm from Italy, which, when fully grown, is but three-fifths of the ordinary weight and size, and the quantity of food consumed is in the same proportion. The cocoons are also of proportionably diminished size. These are by some preferred, as the silk which they afford is very fine and beautiful, and in greater proportion than other cocoons, according to their weight. Each cocoon of this species affords over 2 1-10 grains of silk, and measures on the average but a fraction short of 400 yards. It requires

400 cocoons to weigh a pound, and 4363 are required to afford a pound of pure silk.

4. *Silk-worm of Two Crops.* In Windham, Conn. they have a small pale white worm, which agrees in many particulars with both of the foregoing; if this, and each one of them, are not one and all identically the same. This silk-worm goes through its various mutations in 20 days, and produces fine white silk, which has the valuable property of retaining its clear white color. The worms produce two crops, though the quantity is less than that produced by the large dark colored, or by the large white worm.

5. *Silk-worm of eight crops, or Dacey.* At the silk establishment of the British East India Company at Jungepore, in Bengal, besides the common silkworm, which produces but a single crop annually, they have also another silk-worm, called Dacey, which produces eight crops or harvests, and is supposed to be indigenous.

6. *Friuli Silk-worms.* There is a variety of silk-worms found in Friuli, so very large, that two of these, when fully grown, will outweigh five of the common kind; and their cocoons weigh almost in the same proportion. The quantity of food is 1-10 less in proportion to the weight of cocoons produced, than the common kind, but they require five or six days longer in their evolutions before they begin to spin. Their cocoons are four times as heavy, as those of the *small variety* of silk-worm. Each cocoon yields nearly 8 1-2 grains, and measures almost 1300 yards; and 100 cocoons weigh a pound, and 1091 will yield a pound of pure reeled silk. Friuli silk is said to cause more trouble and waste in its manufacture, than that of either France or Lombardy. This may be owing, either to the breed of silk-worms, or what is much more probable, to its being imperfectly reeled.

OTHER VARIETIES OF SILK-WORMS.

Besides the variety of silk-worms already described, there are several other species, which are highly deserving of the attention of all who would enter on the cultivation of silk.

For an account of the two following kinds of silk-worms, which are described as peculiar to Hindoostan, I am indebted to the researches of Gen. Dearborn, who has described them from *Milburn's Oriental Commerce.*

7. *Arrindy Silk-worm.*—This silk-worm is a species totally different from any hitherto described or known; and is called *Arrindy* from the name of the plant, the *Ricinus* or *Palmi Christi* on which the insect feeds. It is peculiar to the districts of Dinagepore and Rangpore in the interior of Bengal, where it is reared by the natives in a domestic state as they do other silk-worms. The Palmi Christi is largely cultivated in India, as it is also in many parts of France and some other countries, for the abundant produce of oil which is obtained from its seeds, which is known in commerce as the *Castor oil.* This plant is therefore cultivated for the double use of seeds, and also of its leaves.

The cocoons thus produced, are remarkably soft, and white or yellowish, and the filament is so exceeding delicate, that it cannot be wound, as are other cocoons, but must be spun like cotton. The cloth woven of this substance, is white, coarse, and of a seemingly loose texture, but of incredible durability. It is used for the clothing of both men and women, and will wear constantly for ten, fifteen or twenty years. The merchants also use it for packing fine cloths, shawls and silks. Hot water dissolves its texture, causing it to tear; it is therefore washed only in cold water. The Palmi Christi flourishes most luxuriantly in all the states of the south, and in the latitude of Boston.

8. *Tusseh, or Wild Silk-worm of India.* This is

a species of silk-worm which cannot be domesticated. They are so abundant in many parts of Bengal, and the provinces adjoining, as to have afforded to the natives of those countries, and particularly to the Bramins, from time immemorial, considerable supplies of a most durable, coarse, dark colored silk, which is woven into a fabrick called *Tussch-dootie*.

This species of silk-worm, might, it is supposed, prove highly useful to the inhabitants of the south of Europe, and also of the southern states of America, where a cheap, light, cool and durable dress is much wanted: such a dress as this silk affords, and such as is worn by the Bramins of India. Once introduced, they would probably flourish, unaided by the care, and undisturbed by the attentions of man.

SECTION IV.

CLIMATE, SHELTER, ETC.

Wherever the mulberry finds a congenial climate and soil, there also, the silk-worm will flourish. Such a climate and soil, and such a country is ours, throughout its whole extent, from its Eastern to its Western shores. The silk-worm requires a pure atmosphere for the preservation of its health. It has been proved in Toulouse in France, that the silk-worms raised in the huts of the poor peasants, and enjoying the pure air through cracks and broken windows, were from this cause alone, more productive than those which were reared in the houses of the rich in the city.

The silk-worm is a native of China. From China, also, we derive the *Morus alba* or *White mul-*

berry, and the new *Black Chinese Mulberry* or *Morus multicaulis*, these being two of the main varieties on which the insect feeds. The silk-worm is by no means so delicate as many may imagine. Mr. Cobb "saw the insects raised by Mr. D'Homergue in a yard of mulberry trees in the city of Philadelphia, which endured cold, windy days, and storms of rain and thunder; a few of which, notwithstanding, spun in thirty days, and produced excellent cocoons." At Northampton, also, which is a village situated in the valley of the great northern artery of the river Connecticut, the eggs of the silk-worm which had been deposited on the outside of a window frame, remained uninjured and hatched well, although they had endured alternate sunshine, and cold winds and storms, and the extreme rigors of the uncommon winter of 1834–5, and a degree of cold 33 deg. below zero.

Change of climate affects the breed of silk-worms for a time, whether such changes are from cold to heat, or from heat to cold; but of the two, it is better that they should be brought from a colder climate rather than from one which is warmer.

A shelter, however, is necessary for the silk-worm; alike to defend from long and fatal storms, and from their enemies, the innumerable and otherwise useful birds of prey.

SECTION V.

MULBERRY. (Morus.)

The mulberry, or *morus* of the botanists, is a genus comprising many species. It derives its name from *Mor*, in Celtic, *black*. Its origin has been assigned to China,

but several species have been found growing in a wild state in America. It was cultivated at a very early period of time in Western Asia and in Europe, but only for its fruit. The fruit is a berry of a roundish or oblong form; of a color varying from white to red or black; its pulp envelopes numerous small seeds.

Uses. Most of the varieties of the mulberry are esteemed dessert fruits. When perfectly mature, they are grateful to the taste, and very wholesome; the syrup is useful in mitigating inflammation of the throat. The juice when properly fermented, affords a pleasant vinous wine; mixed with apples, they afford a delicious beverage called *mulberry cider*, of a deep red color like Port wine.

The wood of the mulberry tree is compact, elastic and hard, and susceptible of a fine polish; it is therefore sought after by the upholsterer, the carver and the turner. The strength of the timber renders it valuable to the joiner, and also for building boats: its power of resisting the action of water, has been compared to oak.

The roots of the mulberry tree are of a yellow color, and strike downward; and the tree is extremely long lived. M. de Saint Fond saw in 1802, one of the original or parent trees, of all the white mulberry trees of France, which the followers of Charles VIII. had brought from Italy, on his invasion of that country in 1494. M. Lachaux had caused this tree to be encompassed by a wall, to evince his respect and veneration, and to serve as a monument to a tree so inestimable.

Whoever would enter extensively and at once on the cultivation of silk, let them first of all bestow their attention on the culture of the abundant supplies of food; this principal and essential food being no other than the material leaves of the various species of the mulberry tree. Not every kind however is equally suitable. Linnæus has enumerated seven species of those which were known in his day: and amongst these, there are two species, the *Tinctora* and *Indica*, which are not used as

the food of the silk-worm. Those most esteemed and known are the *Morus Alba*, or Common White Mulberry, and the *Morus Multicaulis*, or Chinese Mulberry. This last named is *black*.

The nourishment which is contained in the mulberry leaf is not completely developed till the leaf is fully grown. The leaf, according to the analysis of Count Dandolo, contains—1. The fibrous substance; 2. The coloring matter; 3. Water; 4. The saccharine substance; 5. The resinous substance. The saccharine substance is that which nourishes the insect, augmenting its growth and size. The resinous substance, is that which, "separating itself gradually from the leaf and attracted by the animal organization, accumulates, cleans itself, and insensibly fills the two reservoirs or silk vessels." The proportion of this nutriment depends on the variety of the mulberry, the age, the soil, and the moisture or dryness of the season.

SECTION VI.

VARIETIES.

BLACK MULBERRY. (Morus nigra.)

A TREE which rises from twenty-five to thirty feet—a native of Asia Minor. The leaves are large and rugged. Its fruit is large, black, aromatic, juicy, subacid and good. An agreeable wine is made from its juice. The juice is used for imparting a dark color to liquors; the bark of the black mulberry is a powerful cathartic; and from the bark of the tree, strong cordage and brown paper is made. The leaves will answer for the food of the silk-worms, and are much used in Persia and also in Granada, and it is supposed by them that the black mul-

berry produces a double quantity of foliage. Other varieties however are known, which have obtained a preference over the *Morus nigra.*

SECTION VII.

RED MULBERRY. (Morus rubra.)

A native of America. The tree rises to the height of from thirty to forty feet: the leaves large, cordate, often palmated, and more often three lobed, but usually entire, dark green above, downy beneath, rugged. The fruit is of a very deep red or black color and excellent. This variety is esteemed superior to the black mulberry as a fruit, and the tree is more hardy. The leaves may be used in feeding silk-worms, but they are of an inferior quality for this purpose, when compared with the common white mulberry, or the new Chinese black mulberry, otherwise called the Morus multicaulis, and some other species.

SECTION VIII.

JAPAN PAPER MULBERRY. (Broussonetia papyrifera.)

The tree is of rapid growth, and rises to a large size, with a round head; the leaves are rough, either cordate, entire, lobed or palmated. It is a native of China and Japan, and the liber or inner bark, by being beaten to render it pliable, serves for paper and as an article of clothing in those countries. The fruit is round and curious, but not edible. The leaves are eaten by the silk-worms; and for this purpose, it is now successfully cultivated in France.

A beautiful vegetable silk is procured from the bark of the young branches of the *papyrifera*, as has been proved by M. la Rouverie. He directs that the bark be separated, while the tree is in full sap, and beaten with mallets and steeped in water, by which process he affirms fibres are obtained almost equal to silk in quality, and which, when woven, form a cloth whose texture resembles silk.

SECTION IX.

SHINING LEAVED MULBERRY. (MORUS LUCIDA)

THE leaves are very large, pointed, cordate and shining. This variety is said to be highly deserving of cultivation for the nourishment of silk-worms.

SECTION X.

TARTAREAN MULBERRY. (MORUS TARTARICA.)

THIS mulberry is from the environs of Asoph, and abounds on the banks of the Volga and Tanais. The leaves are large, oval, oblong, serrated, shining. They afford silk of the first quality, and are fully equal to those of the white mulberry or the black. The fruit resembles the *morus nigra.*

SECTION XI.

CANTON MULBERRY.

A valuable species from China. The leaves are very large, cordate, pointed, entire; the leaves grow erect,

having a plain surface of a beautiful shining green. They produce silk of the first quality. The tree is of rapid growth, and said to be hardy, as they endured well the winter of 1835–6, as is asserted by Dr. Stebbins.

SECTION XII.

WHITE ITALIAN MULBERRY. (MORUS ALBA SINENSIS.)

THE white mulberry is a native of China, but for centuries naturalized in Italy, and is therefore called the Italian. A tree of rapid growth and extensively known for the uses of its leaf as the food of silk-worms. The leaves are pointed, cordate, serrate, entire, or lobed, but vary in the different sub-varieties, sometimes even in the same tree in different ages; being at times lobed when young, but when old entire. The bark of the wood is of an ash color; the fruit is white, roundish oblong, of an insipid taste. The tree as before noted, is valuable for its timber, and exceedingly long lived.

In cold climates it grows more slowly; yet its growth is more rapid, and it comes into leaf earlier than the *morus nigra*, and is not, like that variety, incommoded by a profusion of fruit. And although the black mulberry may be preferred in Persia, Count Dandolo affirms, that the white mulberry was found to produce the finest silk of the kinds known in Italy. It is also affirmed, that if the leaves of this species, and those of the *Rubra and M. nigra* be presented to the insect at the same time, it will eat first of the *white*, next of the *red*, and last of all of the *black*. In Malta the white mulberry grows much more rapidly than in Italy; but in India, where the mulberry tree is an evergreen, its growth is so rapid that large quantities are sown and mown in the same season, and from these, sprouts are again produced for a second brood of silk-worms.

Varieties are known in silk countries, which are produced from the white mulberry, and are only to be extended by layers or by grafting. Of these, Count Dandolo prefers those which in Lombardy are called *Folia Giazzola*, and *Folia Doppia*. Other varieties of esteemed kinds, are the *Rose leaved*, the *Roman*, the *Spanish*, and the *Small Queen*; all being sub-varieties of the white.

The *Rose leaved* bears roundish leaves, of large size, and resembling in form the leaves of the rose. The *Roman leaf* is distinguished from others, by its very large leaves, some of which are of the size of those of the gourd. The *Spanish* has a leaf which much resembles those of the Wild Rose Mulberry, except being larger, and more pointed, and is extremely hardy. Those of the *Small Queen* are oblong, tolerable large, and of excellent quality.

The bark according to Rosier, may be converted into linen of the fineness of silk. For this purpose, the young wood is gathered in autumn, during the ascent of the second sap, and immersed for three or four days in still water. It is then taken out at sunset, spread on grass, and returned to the water at sunrise, and this daily repeated, and finally it is prepared and spun like flax.

Other fine varieties which are believed to belong to the same species.

Morus Alba Giazzola.
Feuilles de Parchemin.
Roman Dura.
Nervosa.

Other varieties have been recommended, as one from Italy called *Alpine*, and another from Constantinople called *Broussa*, and the *morus expansa*, which seems to be identical with the *Roman dura*; also the *moretti* or *morettiana*.

SECTION XIII.

MORETTIANA MULBERRY.

This new and most valuable species of mulberry was first discovered about the year 1815, by M. Moretti, Professor in the University of Pavia, and from a single young tree, he had in 1826, multiplied them to 120,000. The leaf is ovate, sharp pointed, entire, cordate at the base. It is thin, smooth on the under and especially on the upper surface, which is of a beautiful and rather deep shining green; it is not near so thick as that of the large white mulberry, called in France the *Admirable*, and is thinner than those of the Spanish mulberry *(Morus nigra.)* It is neither wrinkled nor plaited. It is in general nearly eight inches wide, and ten inches long. The fruit, which is at first violet, becomes at maturity perfectly black, but is sometimes *white*. This mulberry will be most profitably cultivated in the form of a hedge, and from the superior size of the leaf they are gathered with the greatest facility. Its superior quality has been proved by the experiments of M. Gera and Count Dandolo, who assert that they produce silk of a more beautiful gloss and finer quality than common silk.

SECTION XIV.

CHINESE MULBERRY. (Morus nigra sinensis.)

Morus Multicaulis. (*Many stalked Mulberry.*)

Morus Culcallata.

Perrottet Mulberry.

For the first knowledge of the history of this plant, the American public are indebted to the laborious and

unwearied researches of the Hon. H. A. S. Dearborn: and the first complete history and account of this plant, from the "Annales d'Horticulture," and the "Annales Royal Horticole de Fromont:" was communicated to the public from his luminous pen: even before the plant was known by name in this section of the country. I am happy in thus being enabled to ascribe honor, where honor is so justly due. To the introduction of this plant, more than to any other cause, is to be ascribed the awakening and mighty impulse to the cause of silk in this decisive day. [*See the various communications of Gen. Dearborn in Vols. VIII and IX of the New England Farmer for* 1830 *and* 1831.] From this history chiefly, and from all other sources, as well as from much personal knowledge of the plant, I have embodied the following account.

The silk-worms, and the plants whereon they most delight to feed, are the natives of China. These, the *common white Mulberry*, which is sometimes, though improperly called *the Italian*, and the *Morus Multicaulis*, all being alike the natives of the same climate and country.

The Morus Multicaulis is also called, by way of excellence, *the Chinese Mulberry;* a tree of surpassing beauty; a new and most valuable variety for the nourishment of silk-worms; a tree which is represented as possessing such decided superiority over all others, that it will speedily be substituted for them all, in every region of the globe.

Of all the varieties of mulberries for silk, the Chinese mulberry or *Morus Multicaulis* appears that which is most eminently adapted to our wants. It originated in the elevated regions of China, a country famous from antiquity for its silk and renowned for its industry; a parallel only to our own, in its climates and divers latitudes. It is to this tree, that the disciples of Confu-

cius acknowledge their indebtedness for the prosperity and solidity of their empire.

The tree grows vigorous, upright, and beautiful; the leaves large, soft, and tender, are petiolate, cordate, acuminate, serrated towards the summit, marked with nerves, always entire; their upper surface is convex or curled, of a deep and beautiful shining green. The form and dimensions of the leaf vary in different soils. In a dry and arid soil they are of diminished size, their form elliptical, and without the heart-shaped indentation at the base, their breadth being six inches, and their length eight; but in a light, rich, and friable soil, the produce of the foliage is most abundant, the leaves large and cordiform, extraordinary specimens having sometimes measured more than a foot in breadth, and fifteen inches in length.

"Each male flower has a calyx of four concave, oval, membranous leaflets; four stamens, with filaments accompanied with a tridentate appendage; anthers sagittate, bilocular. Each female has an ovary, terminated by two divergent styles; the ovary is unilocular, containing a single pendant seed, which is frequently blasted or imperfect."

It is sometimes called the *Perrottet mulberry*, in honor of *M. Perrottet*, Agricultural Botanist, and Traveller of the Marine and Colonies of France, who has introduced this plant to Europe. M. Perrottet had been sent out by the government of France on a voyage of botanical research, a national ship having been provided especially for his use. It was first discovered by him at Manilla, the capital of the Philippine islands, whither it had been brought by the Chinese from China, as a tree of ornament as well as of eminent usefulness. The Chinese are justly entitled to the credit of its introduction hither, as to all the islands of the Asiatic archi-

pelago, where from motives of industry, they have endeavored to increase and to multiply it, that it might be rendered useful to them in the new country of their adoption.

From Manilla the *Morus multicaulis* was first introduced by M. Perrottet to the Isle of Bourbon, and from thence into Cayenne, and finally it was brought by him to France in 1821, in that vast collection and variety of productions, which he had during thirty-four months procured in the seas of Asia, or gathered on the coast or in the lands of Guiana. At first, however, its cultivation in France was confined almost exclusively to the Royal Gardens, that its trial and dissemination might be thus rendered the more effectual and complete throughout every department of the country. At a later period it was sent from Cayenne to Martinique, and from France to Guadaloupe, also to Senegal. The numerous plants which are already disseminated in the divers climates of Africa, America and Europe, have all been produced by the two individual plants which were brought by M. Perrottet from Manilla.

The *Morus multicaulis* differs from all others, in the uncommon vigor of its growth, and the property which the roots possess of throwing up numerous flexible stalks; the great length which these stalks acquire in a short space of time, and the facility with which it is propagated from layers, or even from cuttings; also, from the remarkable size which the thin, soft, and tender leaves speedily acquire, and the promptitude with which they are renewed. The fruit, which was unknown even in France till 1830, is long, black, and of appearance sufficiently beautiful; its flavor good, being intermediate between that of the Red and that of the Black Mulberry. The silk which the worms form from the food afforded by this plant is not only of the finest quality, but the cocoons are of unusual size, and the fibre of superior strength. The leaves, from their extraordinary dimensions, are gathered with important

economy of labor and of time, and from their superior nutritious qualities, they are preferred by the insects to all others.

This mulberry should be cultivated in hedge rows, and never suffered to rise higher than seven or eight feet. But a few years are sufficient to raise considerable fields of them in full vigor, sufficient to support an immense number of silk-worms; and regular plantations can be formed, by planting the trees at the distance of from six to eight feet asunder; or in rows of eight feet asunder, and the trees at three or four feet distance in the row; a space sufficient for the extension of the branches, sufficient also for cultivation, and for the greater convenience of gathering the leaves. So greatly is this last operation facilitated by the flexibility of the stalks, and the superior size of the leaf, that, as we are assured by M. Perrottet, a child is sufficient for gathering the food for a large establishment of silk-worms.

The *Morus multicaulis*, since its introduction to France, seems destined to replace everywhere the common white mulberry for the nourishment of silk-worms, such is its decided superiority over all others. M. Bonafoux, the director of the Royal Gardens at Turin, and the celebrated writer on silk, has also fully attested its decisive superiority in Italy, where he has found, that by close planting and low pruning, whole fields may be suddenly covered with a mass of the most luxuriant foliage. He has tried them extensively. And M. Dupont, of Chiron, near Chamberry, in France, has found that as the silk-worms fed on this mulberry make less waste of litter and of food, so the chances of disease are diminished from this cause, and they finish their labors in three days less time, and that the silk has a more brilliant lustre. He has also found that the saving of labor in gathering the food is so great, that ten quintals of the leaves of the *Morus multicaulis* are gathered with the same labor that is required to gather two

quintals of the common white mulberry. By the most perfect rules of pruning, he makes this mulberry assume the form of a quenouille or vast distaff, fifteen feet high, the form to be always preserved.

This mulberry braves the most rigorous winters of France. Of this important fact we have the indisputable testimony of M. Poiteau and others; even of the uncommonly severe winter of 1829–30: it has there been acclimated, even to the extreme north, as far as Havre; and where it has been cultivated by M. Eyries, from its first introduction to that country.

Dr. Deslongchamps, in his experiments at Paris, had found, that the cocoons produced by the silk-worms which were fed exclusively on the Chinese mulberry were even rather heavier than other cocoons. And in the report on this mulberry to the academy of Dijon, in August, 1834, by M. Tilloy, it appeared by accurate experiments, that the cocoons produced from this mulberry being rather heavier, the fibre was consequently stronger than that of other cocoons; as it was remarked in winding, that of the whole of these, three hundred and eighty-four cocoons in number, not a thread was broken, which was not the case with the other cocoons.

Near Montgeron in the north of France, the French government have established an experimental silk farm, under the direction of M. Camille Beauvais; and the extraordinary experiments which are there in progress were published in 1835. Already has he succeeded in producing thirteen pounds of silk from the same number of silk-worms which in France usually produced but five pounds, and in Italy seven and a half pounds, and in India twenty pounds; and even in that climate he expects soon to be able to produce an equal number of pounds. And Gen. Talmadge, who has lately visited the establishment, has stated in a letter dated April, 1836, at Paris, that when the leaves of the different kinds of mulberry are mixed together, the worms will select and gather on the Chinese mulberry. And Mad-

ame Parmentier has found on trial at her late establishment at Brooklyn, New York, that the silk-worms left seven other species of the mulberry to feed on this.

In Tuscany, so fine is their climate that two successive crops of silk are annually produced by the common mulberry; and Dr. Deslongchamps has proved, that by aid of the Chinese mulberry, two crops of silk may be annually produced even in the north of France. Our climate is far more propitious than theirs, and at least as favorable as that of Italy; since in the south of that country, the pernicious sirocco, a dreadful south wind, sometimes strikes whole communities of silk-worms dead. The cocoons of the second crop which were produced by Madame Parmentier, being fed exclusively on the Chinese mulberry, were of a brilliant and snowy whiteness. Those also which were exhibited at the fair of the American Institute, in New York, in 1833, of the first and second crops, both being fed exclusively on the Morus multicaulis, completed their labors before midsummer; these cocoons were also of a snowy whiteness.

At the government establishment near Montgeron, in 1835, there were 67,000 mulberries of different species, set out and in a flourishing state, including a great number of the Chinese mulberries; these were kept very low by pruning. M. Beauvais founds his expectations, his sanguine reliance, on this mulberry alone, for the production of the second crop of silk.

The prediction of the late Dr. Pascalis, in 1830, that "*after the discovery of this plant, a doubt no longer exists that two crops of silk may be produced in a single season;*" this prediction has since been accomplished—its truth fulfilled by experiment. The soil and cultivation, the habitations for the successive generations of silk-worms, being yet the same, all thus converted to *double* use, and the production of a *twofold* harvest, it will be obvious that the actual profit, thus augmented, must be manifold.

In a report on this mulberry which was made to the

Academy of Dijon by M. Tilloy, of the Medical Jury of the Department of Cote D'Or, August, 1834, it is stated that in the same situation, time, and temperature, five hundred silk-worms were fed on fifteen pounds of the leaves of the White Mulberry, and five hundred other silk-worms were fed on fifteen pounds of the leaves of the Morus multicaulis ; both finished in the same time. Of the cocoons produced from the White Mulberry it required four hundred and twenty to the pound, while of those produced from the Morus multicaulis, it required but 384; both gave two ounces of very fine silk to the pound, of equal beauty; but it was remarked that in winding the cocoons fed from the Chinese Mulberry, not a thread was broken, which was not the case with the others.

It appears from the deliberations of the French Royal Society of Horticulture, (as noted in the Farmer's Register) that the Chinese Mulberry or Morus multicaulis is not a distinct species, and that as a new and invaluable variety, it can only be preserved by multiplying it from grafts, layers, and cuttings; and that by these means exclusively have the Chinese cultivators reared the tree from time immemorial. And M. Maupoil a Frenchman settled at Lombardy, who propagates the Chinese Mulberry by every mode, has found that plants raised from seed tend to approach in character the common White Mulberry; thence he recommends its propagation by slips and grafting exclusively. Seeds sown near Venice have, it is further stated, produced varieties, but none like the true Morus multicaulis.

For the following excellent remarks on the virtues and mode of culture of the *Morus multicaulis*, the public are indebted to the valuable "SILK MANUAL" of Mr. Roberts, the editor of the *Farmer and Gardener*, which is published at Baltimore This communication is from Gideon B. Smith, Esq., who was formerly the editor of the "*American Farmer.*" Higher authority than Mr. Smith, as a gentleman practically acquainted with his

subject, I need not name. From this communication I have extracted largely, as I deem it very important.

Morus Multicaulis.

"*Editor Farmer and Gardener:*

"Sir,—Having seen many statements and suggestions in the public prints, that the Chinese Mulberry, *Morus multicaulis*, was not as hardy as the White Mulberry, that it would not bear the extreme cold of our winters, &c., I deem it proper to state my own observations on the subject. I was the first person south of New York, who had the Morus Multicaulis. It was sent to me by my old friends, William Prince and Sons, in 1828, in a collection of seven other varieties of mulberry, but under another name.

About a year after I received it, accounts were received from France of the receipt there of the Morus Multicaulis, and of its great value for feeding silk-worms. I immediately commenced feeding my silk-worms with the multicaulis, and from experiment ascertained the truth of all the French had said about it. From that time to this, I have continued to urge upon all, the propriety of cultivating this, in preference to the white mulberry.

Its advantages are:—it is *fully as hardy* as the white; one pound of its leaves contains as much nutritive matter as a pound and an half of the white; the silk made from it is of a finer texture and more lustrous; its leaves are so large, that a pound can be gathered at half the expense and trouble that a pound of white mulberry leaves require; it can be cultivated with infinitely more despatch than any other kind. These are all great advantages, and I am so well convinced of the correctness of this statement, that I do not hesitate to say, that within ten years, no other mulberry will be cultivated for feeding silk-worms; simply because those

who feed silk-worms upon white mulberry leaves will not be enabled to compete with those who feed on morus multicaulis, and they will be either compelled to abandon the silk business, or adopt the multicaulis for feeding. In relation to the hardiness of the morus multicaulis, I have to remark, that I have cultivated it for *seven years;* never protected it in any manner whatever, and never lost a tree by the cold of winter or in any other way. I had fifty young trees in my garden last winter, and not even a bud on the extremity of the branches was injured. It is true abont 50 yards west from where the young trees stood, there is a grove of oak trees, and on the north 50 yards distant, my dwelling house stood; and the garden has an exposure to the south with a gentle declination. But my residence in the winter of 1831–2 was very different. It was a farm four miles in the country in a north-east direction; the situation at an elevation of 300 or 400 feet above tide water. There my morus multicaulis had an open exposure to the north-west wind; yet none were injured. During the whole time, I have had the white mulberry of several varieties, and have observed that they were all equally hardy—none more so than the multicaulis. I have seen the young *unripened wood* of all the varieties destroyed by winter, and was very early led to adopt measures to guard against it, and now I never lose a *bud.*"

"None but the young trees are ever injured by winter, and all we have to do is to give *them* such a start, as to enable them to ripen their wood previous to the approach of very cold weather.

"After the first year, I have never seen any of them lost by winter, except in some extra cases, and in these cases, the white mulberry has suffered, and even the native mulberry, fully as much as the multicaulis. Last winter, a white mulberry tree, seven or eight years old, in the western part of the city of Baltimore, was killed to the ground; while my morus multicaulis, not a quar-

ter of a mile from it, and north of it too, and in a higher situation was not injured."

"In fine, Sir, I am in no way interested now in the business of raising mulberry trees or silk, so that I can be influenced by no mercenary consideration in giving my opinion as above, and therefore, the more dependence may be placed on these suggestions. The manner of propagating as above described, is my own discovery, and has been practised by me four years with invariable success."

Mr. Smith differs from the opinion I had adopted on the authority of the French, as I have stated in page 40, and seems persuaded that this mulberry is a *distinct species*, as is the alba, rubra, nigra, &c.

The plan recommended by Mr. Smith as above, and which originated with him, consists in raising the trees from cuttings in a hot bed. These are prepared and planted early in March, and placed three inches asunder; the eye so buried as to be barely visible at the surface, and covered with glass. The bed is occasionally watered and protected from frost at night, and a scorching sun at mid-day.

By the middle of May, the plants will be six inches high, and may be transplanted to the open ground, and watered daily till rooted. If the weather is dry, they will ripen their wood, and need no protection in the first winter.

SECTION XV.

SOIL, SITUATION AND CLIMATE.

Although the mulberry flourishes most luxuriantly in a moist and rich soil and protected situation, yet the leaves which are produced in such soils are more crude,

and not of a quality so nourishing. The growth of the tree in such soils and expositions, besides being more rapid, is prolonged to a later period in autumn, or until suddenly arrested by frost; and the immature wood of a forced growth, being more tender, is consequently more liable to be killed by early frosts and by winter. Such appears to have been the case in the winter of 1831–2, which destroyed so many full-grown trees of the hardiest description, even to the root. The ravages of that destructive winter seem to have been confined to particular situations and soils; to the productions of the forced growth of a summer not less uncommon and extraordinary.

In northern climates, the young and tender plants of the plum and the cherry, the pear and the quince, and numerous others of the most hardy species, require protection during the first winter in a state of cultivation. Their growth being prolonged, and by art *forced on*, nature demands their protection on a soil *rendered defenceless by cultivation.* Death assails *at the surface*, by the combined and alternate action of the frost and of sunshine; the frost by its expansive power operating on the earth as a girdle, destruction assails at the surface, the point the most vulnerable, and the top *dies as a consequence;* or, their roots taking hold feebly in earth, are cast out by death.

In a state of nature, and in the shades and protection of the forest, or of herbage, the growth of the young tree being slow, and the wood completely matured in *due season*, the case is far otherwise; the bountiful covering of moss, of herbage, or of leaves, with which provident nature clothes the ground, being amply sufficient to modify the growth of the plant, and defend *at the root.* This protection, like the fleecy snow, being two-fold, it defends alike from the blasts of sudden and excessive cold, also from the still more destructive and pernicious rays of the sun. These remarks are equally applicable to the very young trees of the different vari-

eties of the mulberry, to those especially which late in autumn have been transplanted to new positions, or the forced trees of but a single summer's growth; defenceless, unprotected, and all exposed, on an unsuitable and naked soil, they meet the frosts of autumn and of winter unprepared.

A dry, sterile sand is unsuitable; and a shallow soil on a foundation of clay produces leaves of bad quality. In low, rich grounds, and extensive plains or prairies, near ponds, and in the valleys of rivers, the mulberry tree indeed grows most vigorously, yet the leaves being more watery, though voraciously devoured, they prolong the labors of the insect by inducing weakness, and injure the quality of the produce. These grounds are alike exposed to the destructive frosts of winter and of summer: the moisture of the atmosphere in such situations causes the leaves to become spotted and to mildew, and the leaves thus infected, if given to the insects, are the sure sources of disease and of death.

Sunny expositions and the declivities of hills, those especially which slope to the south, east, or west, are favorable. The cocoons of mountainous countries are deemed superior to those of the plains; although not so large, they are usually of a whiter color. Plant the mulberry tree on the high uplands, and on the hills, for here they are neither exposed to suffer from the early and the latter frosts, nor are the leaves liable to become spotted or diseased from the mildew; and from these combined causes, the growth of the tree will be consequently prolonged for a double length of time.

Prepare the soil by suitable nutriment, to the depth of eighteen inches beneath the tree, and to a proper distance around. The roots of the mulberry tree strike downwards; other plants may therefore be profitably cultivated beneath its shade, which is not deemed pernicious, the whole ground being kept as a garden during the first years.

The climate of the countries bordering on the great

northern arteries or rivers is in some degree unfavorable. The winds, which, unobstructed, follow almost invariably the general course of the valleys of these rivers, bring down alternately from high northern regions, and from other climes, a degree of cold, during winter, the most intense and destructive. On the best authority I am assured that the pear, and particularly the peach and the cherry, have during the last winters suffered partial destruction in the valley of the Connecticut, as far south as the country around the city of Hartford, and even still farther downwards and towards the sea. And even the mulberry tree in these regions, is, as I am informed, liable to perish in its top in certain seasons. Even far below the city of Albany, on the Hudson or North river, the cherry tree particularly, and many other trees which are equally as hardy, and especially during all the period of their younger years, are, as I am assured, extremely liable to suffer death during winter, from the same destructive climate and causes.

The proper soils for the mulberry tree are "*dry, sandy, or stony.*" And trees growing on *dry, sandy or stony soils,* and situated on the open plains, and on hills the most exposed to cold winds, will be found to suffer least of all from the destructive frosts of autumn and of winter. With all authors I must agree in recommending a soil of but moderate fertility, and least of all a cold, moist, and heavy soil on a clay foundation, or even a very rich soil; a dry soil on a friable subsoil, on gentle elevations or declivities, being the most suitable of all for the mulberry from China.

Land of middling quality will answer admirably; land less calculated for other profitable cultivation. Land half covered with rocks, may be profitably covered with mulberry trees, which will here find ample moisture, and nourishment, and warmth, from the direct and reflected rays of the sun.

This culture alone is wanting to render the less fertile sections of our fine country rich. Before the introduc-

tion of the mulberry into the less fertile districts of Languedoc, in France, the inhabitants, it has been stated, were miserably poor, though now they are among the richest in the kingdom. A dry upland, and not a very rich soil, is there found to be advantageous to its growth.

Mulberry trees, however, should never be set on the great roads, as the leaves become covered with a coat of dust which is injurious to insects.

SECTION XVI.

CULTIVATION.

The mulberry is propagated by seeds, by layers, or by engrafting.

By seeds.—The seeds are obtained by washing the bruised pulp of thoroughly ripe fruit. The trees for this purpose must be shaken every day. The fruit is mashed in a tub with water till thoroughly incorporated, and the mass being largely diluted is poured off, its place being supplied by new quantities till the water comes off clear and the seed is perfectly clean; it is then dried on cloths in the shade. When *perfectly dry*, it is preserved in bottles well corked, and kept in a dry cool place.

Good mulberry seed will sink to the bottom after steeping a short time in water; and an ounce will usually produce from 5000 to 8000 plants. Previous to sowing, the seeds should be soaked 36 hours in warm milk and water, and after being drained on a sieve they are to be rolled in plaster paris or ashes, and sown immediately.

The seeds are sown in April in the States of the South, and early in May in those of the North—in a rich and well prepared and fresh soil, and warm and sequestered situation; in drills or rows 15 inches asunder, and at an average distance of about half an inch.

Cover the seed but half an inch deep, and stamp or roll the ground immediately, that the earth may retain sufficient moisture at its surface. Carefully hoe and weed during summer, and late in autumn protect with a slight covering of straw, leaves or evergreens; or take up the plants, and secure them in a cellar till spring. This protection, during the first winter, is alike necessary with every variety of mulberry; but after the first winter, protection is no longer required.

At twoyears of age—even at a year old, if the mulberries have grown well, they are to be transplanted, that they may throw out lateral roots. The soil must be rich, and the trees may be set in rows four feet asunder, and 10 inches or a foot distant in the row. Many have found that they make a greater growth to cut them down to two inches above ground.

In the second spring the trees are set in rows four feet asunder, in a rich soil, and a foot distant in the row. By this mode almost exclusively is the *Common White Mulberry* raised, the Common English Black, or *Nigra,* and the American Red Mulberry. But the Morus Multicaulis, otherwise the *Chinese Black Mulberry*, is cultivated exclusively by layers, by cuttings, by inoculating or grafting.

Layers.—Layers are the side shoots bent down, and secured by hooks, and partly covered with earth, their extreme ends only being left out, but previously they should be *tongued*, an operation which consists in cutting the shoot half in two below a bud or eye, and slitting it upwards an inch or more according to the size. This is performed at the bend, and the tongue is kept open by a piece of pebble, and the part covered with fresh earth and pressed down. Thus managed in spring, or at mid-summer, they soon take root, and are separated from the main plant in autumn.

Cuttings, are the twigs or branches of the young wood, or part young and part old, cut in lengths of about six inches, and close below an eye; these are set more than two-thirds of their length beneath a humid

soil, and the ground trodden hard. Cuttings are planted early in spring.

Comte Dandolo and others have recommended to graft the Common White Mulberry, with the large leaved and finer varieties, those which produce abundant crops of leaves; and especially the male plants, as these, producing no fruit, yield larger leaves, which are not soiled and disfigured by the bruised fruit in gathering. Many of the wild varieties are bad, the trees thorny, the leaves small or few in number. They should be inoculated near the ground, or they may be engrafted at the surface of the earth in the third spring.

M. Bourgeous also states that those grafted with the better kinds, such as the *Rose leaved*, and the *Spanish Mulberry*, produce leaves not only more beautiful, but of more nourishing quality and greater number. The same is stated by M. Thome, a name of equally high authority, and one who had devoted to the culture of silkworms 40 years of his life.

The Morus multicaulis is propagated with great rapidity in all the northern and middle States by the following mode. The ground being suitably prepared, the whole tree, divested of a portion of its lateral shoots, is planted horizontally in the furrow; the root placed at suitable depth and trodden hard, the whole top of the tree is covered with an inch in depth of light soil, rendered compact with the hoe; from every lateral and upper eye, shoots will be produced which form fine trees by autumn. From every eye roots are emitted in abundance, even before the eye reaches the surface. No tree hitherto known is propagated more rapidly.

SECTION XVII.

PLANTATIONS OF MULBERRY TREES.

Whoever would enter extensively on the culture of silk, must first of all provide an abundance of the ma-

terial food of the silk-worm. Let the plantations and supplies of the mulberry leaves abound, that there be no lack of nourishment in the latter days, when most of all the silk-worms require very large quantities of food, as any deficiency at that critical period would be without remedy ; for the profit of the silk-worms depends mainly on their being full fed, as the cocoons will in this case be large and the filament strong.

Economy is however important in regard to food, that the insects be regularly fed, and their wants duly supplied, and that none be wasted. Economy is equally important as it regards time; the plantation should therefore be near, that little time be wasted in travelling to and fro.

The roots of the mulberry tree incline downwards, descending deep into the soil: unlike other trees whose roots incline towards the surface, they do not so much impoverish the upper soil; and other plants, whose roots do not descend deep, may be cultivated with profit beneath their shade. It is stated on good authority, that beneath the shade of the groves of the mulberry tree, the pasture is always more valuable and abundant, protected as it is from the scorching rays of the sun.

Formerly, in Italy and in France, the plantations of the mulberry consisted almost exclusively of large standard trees—the surface of the land being covered with groves. Elsewhere I shall give the particulars of the formation of a mulberry grove of 60 arpents at Fontaine, near the city of Lyons, in France, as related to me by S. V. S. Wilder, Esq. Thrice he visited this plantation from its formation, and during 17 years, by which time it had become a source of great revenue to the proprietor. The leaves were not sold to the gatherers till the sixth year, and then the leaves at the tip ends of the twigs were invariably left. In Connecticut the practice prevailed almost exclusively of planting trees at remote distances; and there they climb trees of 30 or 40 feet in height. But orchards of the mulberry, with the trees

far asunder, are not so highly recommended for us;—trees so remotely dispersed are liable to be neglected. Their complete formation is necessarily the work of years, requiring not only a considerable capital, but much patience and a prolonged outlay. Trees of enormous size are more difficult of management and of access, as recourse must be had to long ladders, or to climbing, which is liable to inflict injurious bruises. Time is also wasted in gathering the leaves, and they are seldom gathered completely and regularly; and many years must elapse before the ground can be completely occupied and covered with their shade.

Standard trees may however be set in lanes and other bye-places, on commons, and on land so completely covered with rocks that no profitable cultivation can be effected by the plough; or on the steep and precipitous acclivities of hills. Mr. Wilder has stated it as a fact well understood in France, that mulberry trees thus situated, improve rather than diminish the pasture beneath their shade, inasmuch as they protect from the rays of the scorching sun. On low ground they may be set 20 feet asunder, and but 12 feet asunder on high grounds, and in any situations. But if mulberry trees are set on the borders of great roads, the dust with which they will be covered is injurious to the silk-worms, and must be first separated from the leaf by washing.

Standard mulberry trees may be set on the northern and other cold quarters, as a protection to the plantations of hedges or dwarf trees.

It has also been recommended to enclose the plantations of the mulberry of every description with close hedge to serve as a fence.

In India and other warm countries, the seed is sometimes scattered broadcast, or sown in rows, and the plants are cropped early in the first year, and when the season is wet they will start afresh, yielding a second crop of leaves. But continual close cropping will in time destroy, and these are renewed from the seeds by continual sowing.

SECTION XVIII.

HEDGES, OR DWARF MULBERRY TREE PLANTATIONS.

In China, in India, in Persia and Turkey, and at this day in France, the mulberry is raised in hedge rows, not being generally allowed to rise higher than six or eight feet. By close planting in hedge rows, and by careful cultivation, the land is wholly covered in the shortest possible space of time with a large mass of foliage, yielding a profit both sudden and more immediate, a produce even far more abundant than from full-grown trees. This same system is now gaining ground in Belgium and in Italy. Thus half the labor of gathering the food is saved, and the tedious cultivation of many long years.

Dwarf or Low Mulberry tree plantations, therefore, and their formation, is the mode which I shall recommend for general adoption, for the following reasons :

1st. They arrive to a state of productiveness with comparatively little expense of time and tillage. 2d. Sufficient sun and air are admitted to the tree to render the leaves of the first quality, and to enable them to put forth early. 3d. The ground is more suddenly and completely filled and occupied than by planting standards. 4th. The tree is more easily managed and its form controlled. 5th. The produce of leaves on the same quantity of land, is admitted to be full half as much more from the cultivated hedge rows than from standard trees in their best estate, while the labor of gathering the leaves is full one third less. 6th. Women and children can gather the food with perfect convenience from hedges, which they cannot so easily do at all from large trees.

Rosier, and other modern writers of France, partic-

ularly recommend this mode in preference to all others; and especially have they recommended that the *M. multicaulis* be cultivated by this mode alone: and M. Bonafoux, who has introduced the Morus multicaulis to Milan in Italy, recommends both the plant and this mode of culture, as productive of crops both sudden and more abundant than any other before known.

In Persia, as we are informed, the trees are kept low and not suffered to rise over six or eight feet in height. Broussa, a city of Turkey, at the foot of Mount Olympus, is famous for its silk, and is surrounded by mulberry plantations; the trees, says Com. Porter, are planted in rows, not more than two or three feet apart, and kept pruned low for use, in the season for gathering the leaves, so that a man may reach the top. At other places in this great silk district, the same system is pursued.

The ground being enriched and duly prepared to a suitable depth, the trees may be set in rows eight feet asunder, three feet distant in the row; two thousand trees will thus be required to the acre; the cart-ways transverse; and the ground being cultivated as a garden; but four feet distance would be required in the first years, and other plants may be cultivated between. The leaves may be gathered either in the second and third years, or in the fifth and sixth, according to the variety. In stripping the leaves, those at the tip ends of the twigs are always left. In hot countries the silk-worms are fed wholly on *prunings*, as the leaves thus for a longer time preserve their needful freshness and moisture.

John P. Cushing, Esq. of Belmont in Watertown, a gentleman who has resided many years in China, has stated that the most approved mode of cultivating the mulberry, as practised in that country, consists in keeping them low by annual prunings, like plantations of raspberries. The same mode, according to Mr. Loudon, and also M. Bonafoux, is practised in India. This system of close planting and low pruning is in perfect conformity with the highly approved mode of management,

which is now so extensively adopted with the grape vine, in vineyard culture, in modern France.

SECTION XIX.

GATHERING THE LEAVES FOR FOOD.

The leaves should be gathered from the ground, or if on trees, by step-ladders, as climbing the trees inflicts injurious bruises, galling the limbs. The leaves are gathered in bags kept open with a hoop or strap to pass over the shoulder. Gather them while dry, after the dew has disappeared in the morning, and before sunset. Strip the leaves upwards, not downwards, as this injures the buds. When you begin a tree, strip it complete, except only a few at the tip end of every twig, which must be left as essential to the health of the tree; leave not a leaf—take all, as it injures the tree but more equally and alike in every part. If leaves are left on parts of the tree, by attracting the sap, they rob the other parts which are left destitute, and the tree grows in disproportion. Wet leaves are injurious—they cause disease; therefore never gather them when wet, either with rain or dew, except in cases of absolute necessity; then spread them on a floor under cover, and turn them frequently till dry; or they may be placed during wet weather on a staging formed of tiers of laths for drying, and spread lightly. A stock should always be kept on hand sufficient to last two or three days. When gathered, they should be preserved from wilting in a cool cellar, or by lying spread under cover on a brick pavement, or clean gravelled floor, being often turned and aired, and shifted alternately to new and dry parts of the floor; they may be thus preserved green for four or five days.

The leaves should never be allowed to heat, as even the slightest degree of fermentation produces alteration

in the nutritive substance of the leaf, rendering it injurious to the health of the silk-worms.

The trees of common varieties should not be stripped till after the fifth year from the seed, or not until they have attained the height of seven or eight feet. Too frequent stripping injures the growth of the tree. In cold climates, and where the process of vegetation is slow, the White Mulberry suffers too by frequent stripping. In Tuscany, according to respectable authorities, so fine is the climate, that a double crop of leaves, and a double produce of silk are yielded in a season from the same trees; while in India, where the mulberry is an ever-green tree, many crops are annually produced. I shall refer this subject to that part of the volume which treats more at large on the subject of successive crops of silk in a season. I shall also in that place offer an answer to the remarks of Count Dandolo. The new mulberry so peculiarly adapted for this purpose, was alike unknown to him and to Italy, or indeed to any part of Europe at the time his celebrated work was composed.

In Persia, and in many other hot countries, the silk-worms are fed principally with the twigs or small branches. This mode exclusively has been also recommended by Mr. Smith of Baltimore, by Mr. Goodrich of Hartford, Conn., both gentlemen of much observation and experience. The leaves in this case retain their freshness and moisture a double length of time, and occasion no tormenting thirst.

The leaves of trees are the essential organs of respi ration, and are necessary to t e prosperity and existence of the plant. But during our warm and bright summers, and where the growth is not so much an object, they may be stripped several times during the summer, and their foliage is immediately renewed. Leave a portion of the trees untouched every fourth or fifth year, to recruit; but where they are stripped several times during the same season, they will require occasionally a season of rest.

SECTION XX.

SUBSTITUTE FOR THE MULBERRY.

It seems to have been proved beyond dispute, by practical cultivators, that there is no substitute for the mulberry which can be profitably employed as the food for silk-worms.

Dr. Ludovico Bellardi of Turin, has shown that the silk-worms which have been hatched prematurely, will feed with avidity and prosper on the dried leaves of the mulberry. These are gathered in fine weather in autumn, and carefully dried on cloths in the sun. After being reduced to a fine powder, it is preserved in a dry place during winter. When used, it is slightly moistened with water; then being placed around the insects, they speedily fall to feeding.

Silk-worms have been raised, and in perfect health have spun perfect cocoons, when fed only on lettuce leaves. Miss Rhoades had indeed discovered that silk-worms could not be safely fed on lettuce leaves for a longer period than three weeks, as they generally became sickly, and seldom spun their cocoons. The cause she was led to ascribe to the coldness of the lettuce. General Mordaunt pursuing still further the experiment, succeeded in hatching and rearing silk-worms in a hot house, on the leaves of the lettuce alone. In this case they flourished, producing cocoons of a most perfect quality. Head or cabbage lettuce resists the access of rain or of moisture, and may always be found in a dry state.

Mademoiselle Coge, of Epinal, it is also stated has used with the most perfect success, the leaves of the scorzonera, (viper grass,) the cocoons thus produced being fine.

It is also asserted that the leaves of the *Maclura aurantiaca* or *Osage orange*, have proved to be a valuable food for the silk-worm. This beautiful tree which resembles that of the orange, and proves hardy near Boston, only in dry and elevated situations, has the property of retaining its foliage to a late period in autumn.

SECTION XXI.

MODES OF MAKING SILK IN DIFFERENT COUNTRIES.

Give the silk-worms air, fresh and pure, let them be comfortably warm and dry, and cleanly, and with sufficient space to preserve them from contact, with plentiful supplies of food. These directions alone are sufficient to insure the most perfect success.

Although the art of making silk was for ages involved in obscurity, it is now stripped in a great measure of the dark vestments with which it has been so long and so mysteriously veiled. We were shown in 1835, by H. B. Stacy, Esq., the editor of the Free Press, which is printed at Burlington, Vt., specimens of sewing silk of different colors and the most perfect beauty. Unaided by any experience, and with no other instruction except that which books afford, Mr. Stacy had succeeded in raising and manufacturing several pounds of sewing silk of a superior quality, and worth $10 a pound : yet Mr. Stacy had never before seen a silk-worm, a cocoon, or reel, and was himself astonished to find no portion of mystery attached to the business. The cocoons produced by him were very large, requiring but little more than 200 to the pound. He is persuaded that the main profit depends on *full feeding*, and making the greatest possible amount of silk from every individual insect.

In some parts of China, where the climate is most suitable, the silk-worms are suffered to remain at liberty on their native mulberry trees. There, uncontrolled, and unaided by man, they pass through their various mutations among the branches. When the cocoons are formed, they are collected from the trees, except only a few, which are left for reproduction.

The experiment of raising silk-worms in the open air, was tried in Languedoc, in France, by Monsieur Martely, of Montpelier, in the garden of the College of Jesuits of that city, in 1764. In that year, 1200 francs were appropriated by the Minister of France to defray the expense of the experiment, which succeeded perfectly. In 1765, the sum of 1800 francs were appropriated to defray the expenses of a second trial. But owing to the unfavorable state of the weather, and the heavy and incessant rains, the experiment in this instance totally failed; and though the rearing of silk-worms in the open air has not been attempted in that quarter, yet its partial success taught the cultivators new and important lessons in regard to a more perfect system of ventilation.

In China, when the mulberry tree has sufficiently put forth leaves, the rolls of paper on which the eggs of the silk-worm have been preserved, are daily suspended in the sun—the side on which the eggs are placed being turned from its rays; at night the papers are closely rolled up and placed in a warm situation, and this being daily repeated, the eggs will be hatched in about 4 or 5 days. But in high latitudes the Chinese regulate the temperature of apartments with stoves, that the eggs may hatch simultaneously.

The houses for silk-worms are in dry situations, and in a pure atmosphere, and remote from noise. The rooms are made very close, but with ample means of ventilation, and the doors open on the south. Each room or chamber is provided with nine or ten tiers of frames, on which the rush hurdles are ranged one above another; on these the insects are fed during all the different periods of their growth.

Stoves are also provided in the corners of the apartments, to preserve an uniform and equal temperature, or coals are carried in a chafing dish from time to time backwards and forwards through the rooms.

In China the wants of the young worms are supplied with unceasing attention: they are fed during the night as well as the day. Forty times during the first twenty-four hours they are fed, and thirty times during the second day; but fewer and fewer still on the third day and afterwards.

These sagacious observers, from their long experience, affirm, that as the growth of the silk-worms is accelerated and success insured by the abundance of their food, so also they affirm that the quicker the silk-worms are brought to maturity, the greater is the quantity of silk which they produce. If the silk-worms which are produced by each drachm in weight of eggs, are suffered to linger either through cold or neglect and famine for 30 or 40 days before they begin their cocoons, the product of silk will be but ten ounces. But if their maturity is completed in 28 days, the product will be twenty ounces, while the same quantity of silk-worms which in a warmer temperature, and by being fully fed and well attended, have completed their growth in the short time of twenty-five days, will produce 25 ounces of silk.

The Chinese are fully sensible of the importance of preserving the most perfect degree of cleanliness in their establishments, and are exceedingly careful on this head. When the insect is prepared to spin, mats are provided, and in the centre of each a leaf is affixed an inch in width: this is wound round in a spiral form till the mat is covered, a space being left between each circle of one inch, it having been found that less silk is wasted in the receptacles of these dimensions, than where more space is allowed; also at such periods they exclude the outward air and light, believing the silk-worms spin their cocoons more diligent in darkness.

Seven days after the silk-worms have commenced

their cocoons, they are collected together; and a sufficient number being reserved for breeding, the remainder are placed in layers in large earthen jars with salt, in the proportion of one fortieth part of the whole weight of cocoons between the layers. The whole being covered with large dry leaves, the mouths of the vessels are closely stopped.

The long shining cocoons produce silk of superior quality. These are separated in reeling, by the Chinese, from those cocoons of a thick form and dark color, which are of an inferior quality.

In China, and in Han Choo Foo, according to Sir George Staunton, women only are employed in the fabrication of flowered and embroidered satins, and vast numbers are employed in very extensive factories.

In the hot climate of India, the silk-worms are reared and sheltered in buildings, and beneath sheds, of an open and airy structure; the sides being composed of lattice work, and the roofs covered with thatch; their breadth being generally fifteen feet, with a path through the centre of sufficient width. The height is usually eight feet or more, and on either side, and one above another, and in tiers of from 12 to 16 deep, are the stagings formed of shelves or shallow boxes, formed of bamboo, in which the silk-worms are placed. The posts which support the stagings rest in basins of water, to protect them from ants. When the silk-worms are ready to form their cocoons, they are transferred to cells formed of platted bamboo.

Formerly, it had been the practice in many parts of Europe, to enclose a couple of ounces of eggs in a silk or cotton bag, which was worn in the bosom next the skin, and at night was placed beneath a warm pillow; after three days, the eggs were carefully transferred to thin shallow boxes—these being placed between warm pillows, the heat of which was frequently renewed, as the silkworms were expected to appear towards the fourth day.

In Italy, Count Dandolo had recommended and adopted the plan of using stoves, for warming and regulating the temperature of the apartments in which the eggs were hatched. The heat of these rooms being regulated by the thermometer, is raised during the first day to 64 deg., raising it gradually a degree or two a day, till it shall have reached 82 deg. on the tenth day, and this point is not to be exceeded. Count Dandolo has suggested that one room might answer for all the silk-worms of a whole district.

Fortunately, the necessity of rules like these are unknown in the climate of that portion of America which we inhabit.

In some of the late establishments of France, they have altogether dispensed with the use of fire places and stoves, and the apartments being now warmed when needful by currents of heated air, warmed by a furnace placed beneath, or without the main apartment.

Broussa, a city at the foot of Mount Olympus, like many other cities of Turkey, says Commodore Porter, is surrounded with plantations of the mulberry; and asses laden with the limbs and leaves are continually going into the city.

Mr. Rhind informs us, that in Turkey, the production of silk is confined to the cities or large towns, in the vicinity of which, the mulberry trees are chiefly cultivated by the farmers and landed proprietors, who do not raise the silk-worm themselves. At the suitable season, the leaves are daily collected by them, and sold in the market of the city, as fruit and vegetables are sold. When the season commences, almost every family clear out all the rooms in the house except the one in which they live: the worms being hatched, they purchase sufficient leaves, and strew them over the floor of each room, leaving only a small space round the four walls, for the convenience of feeding; they then place the worms on the leaves, who readily attack them; new quantities of leaves being daily added to supply the

wants of the worms; the litter is never removed, but is suffered to accumulate, frequently to the height of three feet. When the worms are ready for winding, branches and brushes are planted immediately over the collected mass, and on these the cocoons are formed; and these being collected, the rooms are then cleared out, and the reeling is commenced.

This is the rude and abominably negligent mode, practised in Broussa, the great silk district of Turkey, where the best silk is produced. Thus in Turkey, the silk-worms are reared in cities as well as in country villages, and the food is purchased in the market, these cities and villages being surrounded by the plantations of the mulberry.

I have been thus particular in describing the mode of rearing silk in Turkey, not by any means that I would propose it as an example for our imitation, but as a striking proof of the great strength of constitution which is possessed by the silk-worms: and the only mystery appears to be, to comprehend by what power the silk-worms are endued, which can enable them, thus situated, not only to live and survive, but also to produce valuable crops.

SECTION XXII.

SPACE REQUIRED FOR SILK-WORMS.

Five ounces of the eggs of the silk-worm, it is computed, will produce two hundred thousand silk-worms. This appears to be the calculation of the Comte Dandolo, from actual count of an ounce or parts thereof.

Nothing but the most disastrous results can be expected as a consequence, from crowding the silk-worms

too close, and a too confined atmosphere, and an inattention to cleanliness. The silk-worms should in no age be confined so close as to come in contact. An error in these points may prove fatal, and may cause a total destruction by inducing malignant diseases.

With regard to the space which is necessary on the hurdles, for five ounces, or two hundred thousand silk-worms when full grown, the best authors are much at variance. Comte de Hazzi, the professed disciple of Count Dandolo and M. Bonafoux, and especially of the latter, for the statements of both are nearly in agreement, has stated that the amount of space necessary at each successive age is as follows, in square feet:—First age, 50 feet:—Second age, 100 feet:—Third age, 230 feet:—Fourth age, 550 feet:—Fifth age, 1200 feet, or 133 square yards. I shall allow more space, for reasons which I shall shortly state.

Yet the house, as a specimen, of M. Bonafoux, calculated for one hundred and sixty thousand silk-worms on forty hurdles, in stages or stories ten deep, and actually containing eighty thousand, was but twenty feet square, twenty feet in height. For feeding this whole number, forty hurdles were provided; each being three feet wide and fifteen feet long, and containing on their extreme width, and length, two hundred square yards of surface. These must of necessity be piled on horizontal courses or stories, ten deep. But then this house, so small, stood *alone*, by the side of a brook, with five windows, and twenty ventilators opening through the four walls on every side, and in the roof; with a chimney and a broad hearth, for blazing and sudden flame fires. These openings in the roof are very important, as well as the space above.

The utmost extent therefore, which in this house is allowed, is at the rate of 250 square yards, or 2250 feet for two hundred thousand silk-worms, or in that proportion.

By another account, Count Dandolo has stated that

he considers the following estimate as affording sufficient space for a million silk-worms, or in this proportion for a greater or less number. For the first age, 200 square feet of surface; for the second age, 375 square feet; for the third age, 875 square feet; for the fourth age, 2,062 feet; and for the fifth age, about 5000 feet of surface.

But as the great majority of writers, including M. Bonafoux, have allowed more space than Count Dandolo has by this account allowed, I shall consequently vary my estimate. Dr. Pascalis has arrived at precisely the same conclusion—he has stated as from the united testimony of Comte Dandolo and M. Bonafoux, that 288 square yards are required for two hundred thousand, and 12,937 feet, or 1,438 square yards for one million silk-worms.

I have put down therefore 300 yards of surface as a large allowance for two hundred thousand, and 1,500 square yards, or 13,500 feet, for one million silk-worms. And a building, or *magnanèrie*, twenty-six feet wide, and one hundred and thirteen feet long, and two stories high, with double ranges of hurdles of five horizontal courses in each story, will, in our serene and salubrious climate, contain them all with ample space for one million. The first authors are agreed that this space is sufficient, and the right allowance.

Yet if the system of successive crops is adopted, and but four hundred thousand are hatched at a time, and at intervals of seven days, then this same building will suffice for two millions and five hundred thousand, which will here find ample space during the season.

The whole work of feeding in succession by this mode, would be thus completed in seventy-five days. There are varieties of mulberries which will oft renew their foliage, and with no extra cultivation, will continue in a state of vigorous vegetation for more than four months, affording a succession of food during the whole season.

SECTION XXIII.

HABITATIONS, OR MAGNANERIE, HURDLES, &c.

We have seen that the silk-worm is a hardy insect which is capable of sustaining life, and of enduring, unprotected, cold storms of rain, of wind, and of thunder. If, however, mankind would assume absolute and exclusive claims to the labors of the silk-worm, it becomes necessary that they should at least afford them their needful and friendly protection. The silk-worms require a shelter or habitation adapted to their wants and comfort, equal in its style and structure to those which are required for the protection of our flocks and our herds, and our other domestic animals.

In Italy, France, and other parts of Europe, where silk forms a branch of industry of the first importance, the hovels of the peasant, the barns and other outbuildings of the more wealthy, serve for a season the purposes of the silk-worm. In India, as we have already seen, and, in other hot countries, the silk-worms are sheltered in buildings of a more light and airy structure, and covered with thatch. In Connecticut and other climates equally favored, good silk has been raised in sheds and barns, and other outbuildings, which answer well. Shelter is alike necessary to defend from cold winds and humid currents of air, and from storms, as well as from their natural enemies. These enemies of the silk-worm include poultry, and birds of all other kinds which prey on insects; also cats, mice and rats, and ants; these last are excluded from their approaches by surrounding the pillars of the stagings, either with quick lime, or some glutinous substance, or the posts are set in basins of water.

The houses for silk-worms should be in airy situations; they may be built of one or two stories, and may

be constructed of rough boards, matched or tongued. They should be provided with numerous windows of glass; light being essential to the health of the silkworms, and perpetual darkness injurious.

In their own native woods, do they not enjoy the brightness of day and of sunshine, with no other protection from the excessive heat of its rays than the shadow of a leaf? It has also been remarked by an accurate observer, that "on the side on which the sun shone directly on the hurdles, the silkworms were more numerous than in those parts of the hurdles which were in the shade." Protection is however needful from the direct rays of a too powerful sun. Gratings of lath, or of iron wire, a quarter of an inch in thickness, may protect the openings of the windows. These should be principally on the south side. Beneath the windows, and on a level with the floor, are openings: and numerous other openings and doors in the sides should also be provided for the admission of fresh air; fresh air being as natural and indispensable to the insect as light and life.

These openings at the sides are furnished with slides; a small strip of board connecting all the openings on a side of a whole extensive and continuous range, may serve as a common handle, by which all may thus, in an instant, be opened and shut. Near the top, or more properly in the roof, are numerous other openings, or ventilators, through which the impure air will pass out. These in the roof may be of boards or of thick glass, for the admission of light, and may be provided with slides or open with cords, which may be so connected, that all may be opened or shut in the same moment of time. Corresponding openings are left in the floor beneath.

One or more chimneys may be added, with broad hearths for light combustibles or fuel, and sudden or flame fires. These however, are only for occasional use; they serve suddenly to put in motion, and to rec-

tify or expel a stagnant and moist atmosphere; rendering it at once, more healthy and electrical. A stove, also, for heated air, or provided with a common funnel, will be useful, as it will serve, on any extraordinary occasion, to warm the apartment, in case of long and cold storms, which sometimes occur, and may be of occasional use; although I am assured, that in our climate, and in Connecticut, fire is never used in the apartments of silk-worms: still its occasional use may be necessary for their comfort, as it inspires new life.

In the great laboratories of Italy, Count Dandolo has directed that broad fire places should be placed, one at each corner, and two on each side of the centre, and a stove of stone or tile in the middle, in preference to stoves of iron. But now, and in France, they are warmed at times by hot water in pipes of iron.

In case of extreme cold, we have the remedy always at hand. But when the sun pours down its rays with the most intense heat, there is no remedy but to throw wide open the doors, the windows, and the ventilators, and close the blinds, except artificial currents of air are produced.

During hot nights, also, the windows are kept open from evening till morning, except in damp or wet weather. Yet the greater danger being from cold, on the slightest indication of a cold night, you may light up a fire in the fire place or stove, and renew it if necessary.

The insects are fed on thin boards or hurdles; these should be three feet in width, and six in length, running lengthwise of the apartment, and supported by ranges of posts. To prevent the access of destructive ants, the posts may be immersed in basins of water, or the whole staging may receive its support from iron wires or rods, suspended from the timbers above.

The buildings for sheltering and feeding the silkworms are called in France a *magnanèrie*, and in Italy, at the present day, they are called *dandolieres*. Improperly with us, they are sometimes called *cocoonières*, a name which only belongs to the building where the

cocoons are dried and preserved for reeling, after the chrysalides are destroyed. I have described the dimensions of a *magnanèrie*, in the last section, of a size suitable for containing 1,000,000 silk-worms. An extensive building should be of oblong form, and containing two double ranges of stagings, with an aisle six feet wide through the centre, and two other aisles of three or four feet in width, running lengthwise next the walls; for these stagings should never be connected with the outside walls. Thin light boards will answer, with thin ledges at the edges to confine the insects: these slide into their places, and rest on their ends on narrow strips of boards which are nailed to the upright posts. They are arranged one above another in five courses or stories, at the distance of fifteen inches asunder, the lowest eighteen inches from the floor. More properly, these hurdles may be formed of canes or rattans, or split basket stuff, as these being light, are more easily cleaned and dried, with intervals of a quarter of an inch square to admit the air to circulate through.

Netting of twine, attached to the bottom of a square frame of inch boards, forms a fine hurdle, and is deemed a valuable improvement, as it saves much labor. The silk-worms are fed on this netting, and the litter passes through. The netting is secured to the frame by common brads, and may be either formed by simply stretching the twine first in one direction, and then crossing it and weaving wholly by hand,—or it may be wove by machinery; a few very thin laths may be placed edgewise, at suitable intervals, as supports to the netting. The meshes are half an inch wide or a little more. Underneath are slides of paper for receiving the litter, which all passes through. The slides are placed so near, that if by accident the silk-worm gets through, he may either continue feeding below, or, by reaching upwards, he may recover his former station on the netting, at a fresh feeding. If a hurdle of this description, and covered with fresh leaves, be placed on ledges, at the

distance of half an inch or an inch above a shelf or other hurdle containing silk-worms, the insects will instantly and altogether ascend. Thus are the insects preserved from the annoyance of their litter, which is thus easily removed, and a free current and circulation of air is preserved. The hurdles for the silk-worms in the first age are formed of no other material than paper; those of the second age may be fed on paper, on boards, or on netting of a finer description than above stated.

Before the silk-worms are prepared to spin, the netting should be elevated four inches above the board, otherwise some of the most forward worms may begin to form their cocoons in the space between. These slides may be of stiff oiled paper, sustained by laths, or they may be of thin boards.

This mode of feeding the silk-worms was first introduced particularly to notice by the Rev. Mr. Swayne of England. His plan, however, differed a little from that which I have described; the hurdle for the silk-worms of the first age being of paper; those for the second and third age were of catgut with threads one tenth of an inch asunder.

The plan of feeding has been tried by many, both in Europe and in America with the most perfect success. When the silk-worms are sufficiently large to be no longer in danger of falling through the netting, the paper slides may be removed at times, and this will allow a free circulation of air upwards or downwards through the netting.

In America, the plan has been recommended by Mr. Smith, and has been tried by others, and promises to be eminently useful, by ensuring a more perfect degree of health to the insect, and an important economy and saving of full half the labor in this department.

SECTION XXIV.

AMOUNT OF FOOD.

According to Count Dandolo, five ounces of eggs will furnish two hundred thousand silk-worms, which will consume seven thousand pounds of leaves; and one hundred trees great and small, will furnish the food for all, and twenty-one pounds of leaves will furnish food for one pound of cocoons.

Count de Hazzi, from the sources above named, calculates that two hundred thousand silk-worms require ten thousand pounds of leaves in the different stages of their existence, in the following proportions: In the first age, 50 lbs.; second age, 150 lbs.; third age, 460 lbs.; fourth age, 1390 lbs.; but in the fifth and last age, which usually comprises near one third of the brief existence of the silk worm, they will require 7950 lbs.

It is evident that the curious tables of the progress of the insects which some of the best authors have given us, can be no sure guide, even with a regulated atmosphere. The progress, space, and the time and proportion of food, which will be required for the 40,000 silk-worms which are hatched from one ounce of eggs, from their birth till the time they begin to spin, as has been given by M. Bonafoux, I will here state in the abstract. In the first age, 7 pounds of leaves are consumed; in the second, 21; in the third, 69 pounds 12 ounces; in the fourth, 210; and in the fifth, or after the fourth moulting, 1281 pounds. In the consumption of their food, their progress, though irregular in the detail, is uniform on the whole. On the third day from birth, they consume 3 pounds of leaves; on the fourth, but 1 pound 6 ounces; on the fifth day they begin to cast their skins, and, being sick and torpid, they consume but 6 ounces. In their second age, and on

the first day, they consume 4 pounds 8 ounces, thus atoning for previous abstinence; on the third day, 7½ pounds; but on the fourth day, comes on the moulting sickness, and they eat no more than 2¼ pounds. In the third age and first day, they consume 6¾ pounds; on the second day, 21½; on the third day, 22½ pounds; on the fourth, 12½ pounds; and but 6½ pounds on the fifth day; on the sixth day, they become sick, and take no food, this being a critical period; they cast their skin for the third time. On the first day of the fourth age, 23¼ pounds are consumed; but on the seventh, they eat absolutely nothing, and are again torpid, this being the critical period; they cast off their skins for the fourth time. In the fifth age and first day, they consume 42 pounds; on the sixth day, they become most of all voracious, and consume 223 pounds; from this time, their appetite daily lessens, until the tenth day, when they consume only 56 pounds. The silk-worms, which at their birth occupied but 9 feet on the hurdles, now require 239 feet of space, and the whole quantity of food consumed, is 1600 pounds.

According to another account or Diary of M. Bonafoux, two hundred thousand silk-worms were sustained on seventy-two hundred pounds of leaves. But it is admitted that a certain quantity of leaves were given in the intermediate meals, which were not reckoned in the account; also, that in the first stages the leaves were chopped, which enables the silk-worms to consume them without waste. Other and authentic accounts make the amount of food consumed even less than five thousand pounds. We will admit 9000. But much must necessarily depend on care and economy in feeding.

The quantity of food consumed depends also in some measure on the season; if that be moist, the leaves will contain less nourishment, and consequently more weight of food will be required; but if on the contrary the season be dry, less quantities will be required, as the leaves contain much more nourishment.

Something also depends on the species or variety of mulberry which is used. The Morus multicaulis having no gross or coarse fibres, it is found that a less quantity of food of this species, will suffice for the precious insects.

SECTION XXV.

LABOR AND ATTENDANCE.

Mr. D'Homergue has stated, that where the mulberry trees are convenient, as they always should be, two women are sufficient to gather the leaves, and attend to four ounces of eggs, making, at thirty-five thousand to the ounce, one hundred and forty thousand, until the fourth moulting, when more will be necessary, especially in the last ten days. Mr. Duponceau, says Mr. Cobb, raised in the city of Philadelphia, seven ounces of eggs with the labor of two persons, and those not fully employed except the last ten days; and some occasional help, who were employed to bring the leaves from the country two miles distant. Mr. Smith, a gentleman who has paid much attention to the subject, and one on whom we may rely, has assured us, that the labor required to attend one million silk-worms would be, in the first week, two persons; for the second, four; for the third, eight; for the remaining two, fifteen to twenty. Most of these may be boys, girls, or aged women.

The gathering of seventy-five pounds of leaves is considered a day's work, for a child of from nine to twelve years of age in Connecticut, where the trees are large. But thrice this amount might be gathered, or even more than four times, from Dwarf Mulberry tree plantations, in their prime state; and especially hedges of the new large leaved varieties.

SECTION XXVI.

HATCHING THE INSECTS.

The eggs of the silk-worm are of a pale slate, or dark lilac color, and of the size of a pin's head; those of a yellow color are imperfect; but the color of good eggs is often given to bad ones by washing in dark colored and muddy wine. When the mulberry begins to unfold its leaf, and the largest have grown to an inch in diameter, which in our climate, lat. 42° 23′, is towards the last of May, and in settled fair weather, let the papers which contain the eggs be placed on tables in a sitting room of a comfortable warmth, with windows facing the south, but without exposing them to the sun. In such a situation, the warmth of the atmosphere which is usually produced by the sun, is sufficient to hatch the eggs. When the eggs assume a whitish color, or in about ten days, lay over them coarse muslin, or sheets of white paper pierced full of holes, one twelfth of an inch in diameter, or of the size of a large knitting needle, turned up at the edges to prevent the escape of the silk-worm. Lay over the paper twigs containing the young leaves of the mulberry; and the insects, attracted by the smell of the leaves, crawl through the holes and fall to feeding. Those few silk-worms that hatch on the first day, should be placed in a cooler situation than those which come out on the second day, or stinted in their supply of food, that they may be no more forward than the rest. Twice a day the worms which are thus hatched, are transferred to the shelves allotted to those of the first age and allowed suitable space. Being careful to preserve each day's hatching by itself, and marking the date on the hurdle. All usually are hatched in from 48 to 72 hours. Fortunately, the systematic and precise directions for hatching the eggs which I have

described as practised in Italy, are not required by us in our highly favored climate.

SECTION XXVII.

REMARKS ON FEEDING, AND QUALITY OF FOOD, &c.

THE quantity of silk which the insects afford, is in proportion to the amount of food consumed. The duration of the silk-worm is prolonged by a cool season, and by scanty or irregular supplies of food, but the amount of silk, is in this case, greatly diminished. When a crop of silk-worms thus linger, either through cold or famine, for forty days, the amount of silk which they afford is but inconsiderable; while the bounteous harvest afforded by a crop of silk-worms, fully fed and well attended, which in a warm temperature, finish their labors in twenty-four days, will produce more than a double amount of silk. The silk-worm feeds night and day, and the more it is fed the faster it grows, and the sooner it will come to maturity; and in proportion to the dimensions of the insect, will be the size of the cocoon, and the amount of silk produced.

A certain quantity of food being indispensable to sustain life, and the amount of silk which is afforded, being of itself wholly the production of the excess of the food consumed, it follows as a consequence that to feed them profitably they must be fed well.

In Persia they feed the silk-worms with branches, this being considered the most economical mode for a hot climate, as the leaves retain their freshness and flavor for a longer time, being devoured with less waste.

The Italians insist on cutting the leaves fine; but Mr. Smith and some others in America have rejected this mode, after trial, as the silk-worms tread down the

cut leaves, passing over them and causing waste. They prefer twigs or small branches, as the leaves keep longer in this state, or until consumed, and are more consonant to the natural habits of the worms. It has also been noticed that the worms avoid the cut edges, and attack the leaf in any other part in preference. A dozen leaves torn in pieces at each feeding, will support a great many worms during the 1st, 2d, 3d and 4th days, and but a very few leaves will suffice during the first ten days. Constant attention will soon enable the intelligent attendant to discover the quantity of food necessary, and to avoid on the one hand stinting them in the needful quantity, or on the other hand a needless waste by over supplies of food.

The young leaves, being replete with moisture, are the only suitable food for the young silk-worms, as their bodies transpire largely: and as the mature leaves contain a greater proportion of solid and nutritive food, so they are the only suitable food for the silk-worms of a more advanced age.

Leaves of a crude and watery consistence, like wet leaves, occasion disease—leaves which contain the most nourishment, being alone the most suitable. The best leaves are produced in dry seasons and on dry soils, and on the trees of a more advanced growth.

In the early or first ages of the silk-worm, the amount of food consumed is very small; but the amount is very great in the last age, as their dimensions and bulk are wonderfully increased.

If the longitudinal dimensions of the insect be compared during the different ages, and their length at hatching being unity, or 1, then at the end of their first age, their length will be 4; at the end of the second age, 6; at the end of the third age, 12; at the end of the 4th age, 20; at the end of the fifth age, 40.

I have shown in the history of the silk-worm, at p. 18 and 19, that the duration of the insect is prolonged by cold; on the contrary, the vital functions of the silk-

worm are accelerated by warmth, and also by the degree of attention which is bestowed on them.

In a regulated temperature, or such a temperature as Count Dandolo has prescribed, and where the heat indicated by the thermometer is gradually reduced from 75 deg. on the first day to 68 deg. on the last, though the weather is constantly growing warmer; in a temperature thus regulated, their various changes or moultings usually occur on the 5th, 9th, 15th and 22d days, and they usually will quit feeding on the 32d day. But in warm climates, as I have shown, the various mutations or changes are hastened; but it seems agreed, that the amount of food consumed is the same. It is evident that the Diary, which I shall omit, is only for the regulated temperature.

SECTION XXVIII.

FEEDING, CARE AND ATTENTION.

1st Age. The eggs of the silk-worm being hatched by the natural warmth of the atmosphere, are removed to papers placed on the hurdles. They are of a black color, one twelfth of an inch in length; those of a red color may be thrown away. Feed with but a small quantity of the young leaves or branches at a time: these leaves may be torn, as the worms eat them with less waste: feed them four times during the twenty-four hours. When the young brood are piled too close, a part may be removed on the young twigs or branches. They eat well for about three days, when they grow torpid, and must not be disturbed till they awake. You need not remove the litter during this stage; but during the two following stages, remove the litter to a table in an apartment separate, and strew over a few leaves, and you will

recover any lost worms. After each and every successive change, their appetite increases daily more and more, but gradually diminishes as their change approaches.

2d Age. The silk-worm now awakes hungry; but let those which awake too soon, still hunger, till all are awake, that all may be equal; they have now become of a dark ash color; feed them for about two days with branches, and with young leaves and branches, or older leaves torn fine, when they will grow torpid and are not to be disturbed. The litter during this stage is to be often removed. You may bait the silk-worms to any corner of the hurdle by a few leaves when you choose, for the purpose of sweeping the litter. Or you may remove them to other shelves or hurdles on branches.

3d Age. Continue feeding the silk-worms with full-grown leaves. The silk-worms are now of a light gray color, and the mouth with which they saw their food is changed in color, white and soft, but soon becomes hard and black, continually growing harder with every successive change. Place over them the hurdles of twine netting covered with leaves, and they will all pass upwards; or remove them on leaves. Clear the litter often—once a day at least.

4th Age. In this age the silk-worms are of a whitish flesh color, except the spotted species called tigres, their head and body has become enlarged. Their appetite becomes voracious. The coarsest leaves are now greedily devoured.

5th Age, and last. Their color has now become of a dusky gray with a reddish hue, they continue however growing whiter for about seven days, when they gradually become of a yellow color, their backs become shining, and their mouths of a red color. Bags of leaves are now introduced and distributed; they now devour incredible quantities of full grown leaves: even the coarsest leaves are equally valuable, and night and day they must be fed to the full. Their time now be-

ing short must be improved continually, and to the utmost; for now they hunger incessantly, and the more they eat, and the faster they feed, the more abundant will be the produce of silk. During this and the former age, abundance of litter will collect from prunings or straggling branches and the stalks of the leaves—all must be removed at frequent intervals, and when the warmth of the atmosphere will admit, as in the former ages, the numerous windows in the roof and sides must be opened, to preserve a pure atmosphere. When the atmosphere is damp, it must be excluded; and the litter removed the oftener, lest pestilence should ensue. If you use the netting which I have described and recommended, it may save you much labor, and will be eminently conducive to their health. They delight in all the latter stages in a cool, fresh and pure atmosphere. When the weather is parching, hot and dry, sprinkle the floor with water occasionally, and keep shallow vessels filled with water to rectify the air. Rectify a hot, moist and stagnant air by sudden flame fires. Chloride of lime is now the all sufficient and powerful cure for a bad atmosphere. A spoonful may be placed in a broad saucer, and to this five or six times its bulk of water is added. These are placed in various quarters, on the floor of the establishment, and replenished every three days. It may be bought cheap at the apothecaries. During every age, and until the silk-worm has ceased taking food, it never inclines to wander; a circumstance which has rendered this insect wonderfully easy of control.

SECTION XXIX.

FORMATION OF THE COCOONS.

When the silk-worms become transparent, and of a clear pearly color; when they cease eating and run to and fro, looking upwards or trying to ascend; when their skins about their necks become wrinkled, and their bodies have a softness to the touch resembling soft dough, and their backs become unusually shining; when the green circles round the body contract and become of a bright gold color, these are sure indications that they are prepared for their last work of forming the cocoons. Then and not before, the arbors are formed from the brush or twigs of the oak, with the leaves on, which had been before provided; and the silkworms are concentrated to half the space occupied by them before. The leaf of the oak is strong, and the cocoon is separated from it without injury by crumbling the leaf. These should be cut and dried three weeks previous, and preserved in readiness till required. They are placed around the edges of the frame upright with the top spread, forming arbors 15 inches or more in width, with circular heads.

It is important to attend particularly to the preparation of the hedges or receptacles for spinning: If the air be too much impeded, or the insects too much crowded, many of the cocoons will be double or otherwise imperfect, or the silkworm may be suffocated before its labors are completed. Mr. Gideon B. Smith, of Baltimore, prefers broom corn, which is placed pressing against the shelf above and in a spreading position. The oak leaves are used by Mr. Cobb. Dr. Pascalis has found that two hurdles formed of split canes or rattans and secured together by hooks and staples at top and bottom, and placed vertically, a little inclining,

and an inch, or an inch and a quarter asunder, answer admirably; the front one should be elevated an inch, that the insects may find a passage upwards from beneath. Three hurdles placed together in this mode will form two spaces, which the silk-worms soon find and fill.

Hurdles of the twine netting are found to prove too smooth to enable the silk-worm to attach firmly the cocoon: They might however answer well if placed opposite a hurdle of rough sawn laths and at an inch distance.

Hurdles twelve or fourteen inches wide, and three feet long, are formed of four strips of inch square boards. The bottoms of these are covered with very narrow sawed laths, with spaces of about half an inch asunder. Two of these are placed together and secured by hooks; the space left between the hurdles being but an inch. Were the space greater than this, *dupions*, or *double cocoons* would be formed, which are considered of but little value; these being formed by the united labors of two silk-worms, can never but with difficulty be reeled. But the space being thus reduced to an inch, two silk-worms will seldom or never unite to form dupions, as they find not sufficient space. These thus connected, are placed edgewise or a little inclining, at each end of every hurdle. When filled, they are opened, and the cocoons are readily and quickly separated from the hurdles, with no rubbish or broken leaves adhering, and with great saving of time. It usually requires the insect from four to seven days to form the cocoon.

During the first day the insect forms a loose oval structure of thin irregular coarse threads called floss. Within this structure during the three following days, it forms the silken ball, not however in concentric circles, but by irregular movements backwards and forwards in spots. The silken fibre is covered with a gum which contributes to exclude the water.

Sometimes even after its ascent among the branches,

the silk-worm will look back and descend once more for the last time to partake of food. Sometimes also during the last period, and previous to the ascent of the insects to form their cocoons, some of them appear languid. Anciently it was found efficacious to introduce fried onions to the apartments—the pungency of the odor of which, while it induces some to partake with an appetite their last meal, will inspirit others to ascend to their last labors. But in modern times it has been found, that simply removing those silk-worms which thus languish during the last stages, to a warmer temperature, will never fail to inspire them with renewed life.

Ventilation is very important during the period while the insects are peforming their last labor; yet in no case is a due and comfortable degree of warmth more needed than while the insect is forming its cocoon, as this enables them to draw forth and to surrender the whole amount of silk which they had laid up in store.

SECTION XXX.

MALADIES OF THE SILK-WORMS.

Diseases of silk-worms, like epidemics in crowded cities, when they do occur, are generally caused from want of air and space, or from being fed with wet leaves, or from inattention to strict cleanliness, and want of a frequent change or of wholesome air. Whenever any of them appear sickly, they are to be removed to a separate corner or apartment, and placed by themselves on a separate hurdle, called the *hospital*, that they may not infect the atmosphere, and spread contagion. A very damp state of the air of long continuance being unwholesome, is to be corrected by flame fires.

Chloride of Lime, which is now used so extensively

in bleaching, in cotton and paper manufactories, has been lately found an antidote to the plague of Cairo in Egypt, when sprinkled daily on the floors. This is one of the most cheap, convenient and powerful agents which can be employed in neutralizing the pernicious effects of mephitic vapors, and rectifying the impure air which arises in hot, damp weather, or from neglect in silk-worm establishments. It is not only the effectual preventive but the all-sufficient remedy for epidemic disease. A spoonful or two may be placed in a broad saucer or plate and covered with five or six times its bulk of water, and replenished every three days. Diseases of silk-worms are few or absolutely none, where things are rightly managed. Count Dandolo was even obliged to have recourse to others for the knowledge of diseases which were unknown in his establishment. Yet when diseases do occur among silk-worms, they appear to arise principally from a damp, stagnant, or mephitic atmosphere, a want of cleanliness, or improper food, consisting of wet leaves, or leaves which have partially undergone fermentation.

By evaporation, as well as by respiration, an incredible quantity of fluid of an unwholesome nature is continually disengaged from the bodies of the insects. Effectual measures should be taken to disperse this source of disease. This unwholesome atmosphere, says Count Dandolo, operates as a continual conspiracy against their health and life; and their capacity of resisting and living through it, proves them to be possessed of very great strength of constitution. It is even affirmed that in high and dry situations, where the temperature is between 68 deg. and 70 deg. and the air preserved in the apartments in a dry and pure state, that disease cannot enter, and the silk-worms will remain as healthy as on their own native trees, and with full feeding the crop will be as abundant.

SECTION XXXI.

COCOONS FOR PRODUCING EGGS.

SELECT for seed, the best cocoons; those which are of largest size, and feel firm, and are of a bright color; an equal number of males and females. The male cocoons are slender, depressed in the middle, and pointed at both ends. The female cocoons are of larger size, of a rounder form, and resemble in shape a hen's egg. Some have recommended to reserve the dupions for hatching. Having stripped the floss, they may be strung together by threads, being careful not to pierce the cocoon, and hung up to the wainscot in festoons; or they may be placed in a single layer, in open paper boxes, on shelves or tables, in a darkened, retired, and warm, airy, room or chamber. In from 10 to 18 days from the time they complete spinning, according to the warmth of the climate and season, the moth emerges from the cocoon, a large butterfly of a grayish white color, with four wings, two eyes, and two feathery plumes or horns. The male usually appears first, and is known by his smaller size and a continual flutter of its wings. The female is of a larger size, of a whiter color, and seldom moves. These are to be paired, and removed by their wings to sheets of paper spread on tables or boards, where they are to be left shut up in darkness. The *phalæna* being a night insect. The female usually commences laying in about from twenty-four to thirty-six hours after leaving the cocoon, and lays from three hundred to four hundred eggs, disposed in a circular space on the paper, to which they adhere. One sixteenth part of the cocoons are sometimes reserved for this purpose as a great allowance. One hundred pairs of cocoons, which weigh a pound, will produce an ounce of eggs; and an ounce of eggs is computed to produce forty thou-

sand silk-worms. These papers are to be carefully rolled up and placed in close tin boxes lined with paper, and preserved in a cool room or dry cellar, where they will not freeze; but freezing, though it may injure by retarding the period of their hatching, yet it does not destroy.

SECTION XXXII.

STIFLING THE COCOON OR CHRYSALIDE.

WERE it convenient to reel the silk from the cocoon immediately after it is spun, it would be the best possible mode; but where it is not convenient, the insect contained in the cocoon must be stifled within about ten days after the cocoon is completed, otherwise it will perforate the cocoon, which would thus be rendered of little value.

In many climates the power of the solar rays is found to be sufficient to destroy the chrysalide in the cocoon. This is an excellent mode, and it is found effectual in India, in Italy, and in America. As far north as Burlington, Vt., it has been tried by Mr. Stacy with the most perfect success. The cocoons are exposed fully to the scorching rays of the sun in a cloudless day from 10 o'clock in the morning till 4 in the afternoon, when they are to be closely wrapped in dark cloths which have undergone a like exposure to the sun's intense heat. Thus exposed during three days, to a degree of heat equal in the sun to 88°, their destruction becomes effectual, as may be ascertained on trial. Cut open a cocoon and prick the chrysalide with a needle; if living, it will then show signs of life. There may be no better mode, and cocoons thus managed, will appear remarkably bright and fine.

In more temperate climates, or in some parts of

France, ovens are used for destroying the insect. The cocoons are placed in oblong shallow baskets covered with a paper, and over this a cloth, and these are placed in an oven, the heat of which should be *very nearly* that of the oven after the bread is drawn. Thus wrapped up and exposed during half an hour or an honr, the chrysalides taken from the centre of the basket will be found dead. On removal from the basket, they are covered closely will blankets for a few hours, and then dried in the sun. Steam of boiling water is a mode of destroying equally effectual. Boiling water is poured into a large wooden trough or vessel to the depth of two feet. Over this the cocoons are placed in a basket of the same form and size: this is covered close with wollen cloths, and the basket is lowered to within an inch of the surface, that the steam may pervade the whole mass—new quantities of boiling water being added to keep up the steam, in two hours the chrysalides will be found dead. The cocoons are then removed and covered close with woollen cloths, and afterwards spread in the sun to dry. 189° to 200° is the heat usually prescribed for killing the chrysalides, either in the oven or by steam.

Stifling by steam, observes M. Amans Carrier, injures the lustre, particularly of the white silk. And Monsieur Baumé, the celebrated chemist, has also remarked, that in the modes usually adopted for the destruction of the chrysalides, the cocoons were rendered harder, and more difficult to reel than where no artificial heat had been applied; and that the lustre is also injured in the process of *baking*. His mode consisted in placing the cocoons in large boxes, in layers six inches deep: on these spirits of wine were sprinkled from a watering pot, and equally distributed over the whole cocoons, in the proportion of half a pint to every superficial foot of surface. On these another layer six inches deep was placed, and a like proportion of spirits of wine distributed over the whole; and so continuing till the box was filled. All being covered during 24 hours, a spon-

taneous heat ensues, which is sufficient to evaporate the spirit, which penetrates the cocoon with power to destroy the chrysalides; the cocoons are afterwards spread to dry, and are then ready for reeling, with no aid from hot water. M. Beaumé states that silk thus managed, not only exhibits a greater degree of lustre, but that the proportion of the silk reeled will be one ninth part greater than when the cocoons have been subjected to the heat of an oven.

By enclosing the cocoons in tin boxes, and, after sprinkling with spirits of wine, closing up the box and placing it in the sun, the chrysalides are in like manner speedily destroyed. Or, by enclosing them in a large wooden box, with a few small perforations in the top, and admitting at the bottom the steam of boiling whiskey or New England rum, the same effect is produced. Camphorated spirits are still more powerful and effectual. When these are used, the boxes containing the cocoons should be closed for a time, and placed near the fire; such cocoons are ever after secure from the attacks of moths.

The reeling should commence as soon as the first cocoons are completed, and should continue uninterrupted. Those cocoons which become spotted in destroying the chrysalides, must be separated and reeled immediately.

By whatever process the chrysalides have been destroyed, it will be necessary to dry them thoroughly, either in the sun, or in rooms expressly appropriated to this use, which are called *cocoonieres*, and may be provided with a stove. These rooms are provided with shelves placed in tiers two feet asunder, and formed of laths. The legs of the supporters and the whole being insulated and secure from rats and mice, which are immoderately fond of the chrysalides. Air is continually admitted, and the cocoons which are spread to the depth of a few inches, are continually watched and turned every day, till thoroughly dry.

SECTION XXXIII.

TRANSPORTING COCOONS.

Cocoons when sent to market, or to the filatures at a distance for reeling, must be put up with a suitable degree of care. Particular attention is necessary in handling and packing, that they be not dented or flattened, as this would be highly injurious. The cocoons when perfectly dry, are to be packed in tight and perfectly dry boxes, or barrels, and sufficiently pressed down to prevent chafing, but not so hard as to alter their form. Thus managed they may be safely transported to any distance by water or by land.

SECTION XXXIV.

REELING.

In silk countries, an establishment for reeling is called a filature, and the winding of the cocoons is generally conducted as a separate business, distinct from that of raising silk-worms, and the silken balls become an article of traffic, as soon as the chrysalide within has been destroyed.

Everything, it is admitted, *depends on reeling*. So important, indeed, is this branch considered, that an essential portion of the profit depends on its being properly performed. If the reeling has been but indifferently performed, the silk may not sell for more than four dollars a pound, but if well reeled and skillfully executed, it may bring from six to seven dollars, possibly more,

according to the demand at the time; and it is stated by Count Dandolo, as a well known fact, that of two reelers, each reeling seven and a half pounds of cocoons of the same quality, while one will be able to obtain but six or six and a half ounces, another will obtain eight ounces.

Until very lately, most of the silk which was made in Connecticut was converted into sewing silk; and I have seen the statement that in 1831, more than $81,000 worth of sewing silk was made in the town of Mansfield alone. Yet "the Connecticut sewing silk," says Mr. Cobb, "at present does not bring a higher price than the reeled silk as it comes from my reels. As it is said there is a loss of one half of the weight in the preparation of the sewing silk, it is evident that to reel it properly, and sell it for raw silk, would bring a hundred per cent. extra profit.

The difficulty of reeling is only in the beginning, and is soon and easily conquered. *Practice, perseverance,* with diligence, will soon enable any one to attain the art to perfection. Those there are, it is well known, who with little or no instruction, soon became most skilful reelers. I will speak of Mrs. Church, the lady of Samuel Church, Esq., of Bethlem, Conn. "We have seen several specimens of the reeling of this lady, the present season," says Judge Comstock, "which we do not hesitate to pronounce equal to any foreign silk we have ever seen, and what is most surprising, they are the results of some of her first attempts at reeling!

For the want of those suitably skilled in reeling, the cocoons are stated to bring but from thirty-seven cents to fifty cents a pound, while but eight or nine pounds only of the best cocoons are required for a pound of pure silk.

Even the bounties now so liberally offered by Massachusetts, Pennsylvania, New Jersey, and some other States, which amount to two dollars for every pound of silk raised and reeled within those States, will, in the

opinion of good judges, fully pay for all the expense of raising and of *reeling well*, leaving the whole amount of silk as clear profit.

Mr. Nouaille, according to Mr. Cobb, has stated, "that at Novi (Italy) a woman experienced in the business, with the assistance of a girl to turn the wheel and attend the fires under the cauldron, can with ease reel off one pound of silk, consisting of four or five cocoons, of the most perfect quality, in a day. These reels carry two threads each, two skeins being reeled on the same instrument at the same time. But where silk of ordinary quality is wound, one person may with equal ease attend to the reeling of five, or six, or even more skeins, all which are wound at the same time on a reel of more extended dimensions. Mr. D'Homergue says a woman may now reel three pounds a day with the aid of her attendant. The Americans will be able to dispense with the labor of this attendant, and to substitute a cheaper species of laborers than even are those of any part of Europe,—I refer to our abundant natural resources. At Mansfield, and at various other places, reels are now moved by water power, or by steam.

The filaments of the cocoon are cemented together by a gum; to dissolve this gum requires the aid of hot water. This gum is very important, and is not separated till the silk is twisted into tram or organzine; the gum serves to unite and combine the individual fibres while winding, and as a cement uniting the ends of the continuous thread which is formed by the continual additions of new filaments to replace those of the exhausted cocoons. It is important, also, that the reel should be moved with a suitable degree of speed, that the filament may unite while warm and adhesive. Also, it is an essential requisite to the production of good silk, that before the silk touches the bars of the reel, it should have lost by drying and by cooling, a good part of this adhesive quality. For this reason, the reelers of

Piedmont are obliged by law to allow the distance of thirty-eight French inches between the guides and the centre of the reel. This, and the slowly-traversing movement of the layer which winds spirally over the reel, backwards and forwards, and the circulation of the air, caused by the motions of the reel, dries the gum sufficiently to prevent the adhesion of the threads.

Whoever would acquire the art of reeling silk, must first of all be provided with an appropriate and well constructed silk reel. Such an one may be either purchased or made at a trifling expense. The French reel is a new and highly improved instrument of very modern date. Reels on the plans which I have described may be purchased at the agricultural ware-houses in our principal cities, constructed at an expense which may vary from five to twenty dollars each.

Mr. Gideon Smith's Silk Reel is an improvement on the silk reel of Piedmont and more simple in its operations. The improvement consists in substituting a drum wheel and pulley, and band, or cord, for the cog wheel of the Piedmontese reel. The pulley is attached to the reel itself, and is ten inches diameter; the drum wheel is connected with a spiral groove which gives a vibratory motion to the traversing bar by means of a pin. The size of these wheels precludes the liability of the band slipping; and such are their proportions that while the reel performs nine revolutions, the drum wheel performs five revolutions, causing the traversing bar to move backwards five times, and five times forwards. The spiral groove, which gives motion direct to the traversing bar, is formed precisely like that of the French reel, although it is somewhat different in its operation.

Mr. Cobb's Reel combines great power and efficiency with great simplicity of construction. The principal difference between this reel and that of Piedmont consists in this, that the horizontal wheel, or drum, which gives motion to the traversing bar, receives its motion from a band, or cord, and a pulley connected with the

reel, instead of cog wheels, as is the case in the Piedmont reel.

Mr. Dale's Reel is an improvement on Mr. Cobb's reel, from which it only differs in receiving its motion by having the handle affixed to the drum wheel, which is placed near the basin, by which means the same person who attends to the reeling may at the same time turn the reel. In the other reels the handles are usually affixed to the reel itself.

Gay's machine for reeling has much simplified the process, winds at once the silk from the cocoons upon the spool, instead of a reel, and is stated to be so simple in its construction, and so easy in its management, that any woman will acquire sufficient knowledge of its use in two hours' instruction, to become tolerably expert in the art of reeling.

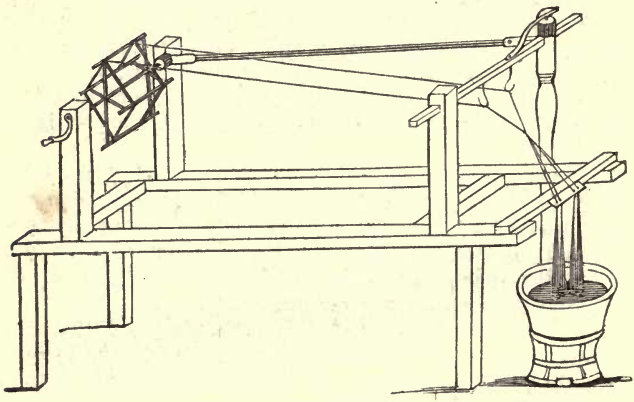
On the spools on which it is thus wound, it can never get entangled, as in skeins, and it is wound in one continuous thread, and may be transported to any distance, and kept for any length of time without injury, and as is the case of the spools of cotton thread, it may be wound off entire and without injury.

The machine of Mr. Gay occupies but little space, and may be used without inconvenience, by the fireside, and although, in nearly all cases, before the silk is to be manufactured it will still be necessary to reel it from the bobbins or spools, into hanks or skeins, yet the other advantages in reeling, and keeping, and preserving the silk or spools, are stated to overbalance the trouble of two windings. This, as well as all other reels, and the loom, may be moved by water power.

In Piedmont, silk of the best quality has long been produced; to this high character which they have so long maintained, they are indebted to the *Piedmontese Reel*. This reel has served as the foundation of numerous improved reels, and is formed of four bars, or arms, and is usually a yard in circumference. One of these bars is provided with hinges that it may fold inwards towards

the centre, when it becomes necessary to slacken the silk that it may be carefully removed from the reel. The traversing bar, which carries two iron wire guides through which the threads pass, receives its lateral motion, by being connected by a pin to the outer circumference of a horizontal wheel. This wheel receives motion by other cog wheels which are connected with the reel.

PIEDMONTESE REEL.



FRENCH REEL.

The following Description of the French Reel, is taken from the work of Dr. Ure, page 265.

Fig. 1 and 2 represent, in plan and longitudinal view, the reeling apparatus used in France.

a. The oblong water basin, heated by steam or a stove, commonly divided by transverse partitions, containing sometimes twenty cocoons, five in a group.

b. Hooked wires, or eyelets, to guide several filaments and keep them asunder.

FIG. 1.—PLAN OF REEL.

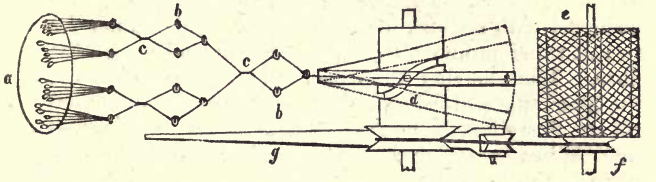
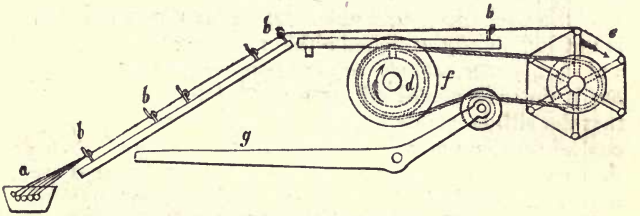


FIG. 2.—SECTION OF REEL.



c. Points where the threads run across each other to clean their surfaces.

d. Spiral groove, with a pin to give the traverse motion to the thread, in order to spread it over the reel *e;* the traversing bar moving horizontally to and fro, in the arc of a circle.

f. Pulleys, which transmit by cords the rotary movement of the cylinder *d*, to the reel *e;* the pulley connected with the reel being the smallest of the two.

g. Friction lever, for tightening or slackening the endless cord, in setting or stopping the winding operation. There is usually a series of such reels in one apartment, driven by one moving power; but each of them, as shewn, can be stopped at pleasure.

The use of the reel requires a dexterity which is easily acquired by practice. The cocoons being cleared of floss, are thrown by handfulls into basins of pure soft water, placed over small furnaces of charcoal fires. When the water is almost at boiling point, sink the cocoons, with a whisk of broom corn, under water for two or three minutes, to soften the gum and loosen the fibre. Then moving the whisk very lightly and softly, the filaments will adhere to it, and may be drawn up till the flossy silk is unwound, and the fine silk comes off. When a sufficient number of the filaments are collected to form the thread, it is passed through one of the holes of the iron or glass plate connected with the guide and traversing bar, and tied to one of the bars of the reel, and the reeling begins.

If the cocoons bound upwards, it shews that the gum is not sufficiently softened; the reel must be slacked, and hot water added, or its temperature increased: but if the silk comes off in lumps or burs, this shews that the silk is yielded from the cocoon faster than it can be received on the reel, and that the water is therefore too hot; cold water is added, and the motions of the reel are quickened.

Each reel carries two compound threads, and it has been recommended that the second thread be wound two or three times round the other thread, previous to being passed through its guide, and secured to the reel; this crossing and friction makes a rounder and smoother thread.

Stir the cocoons very lightly; if struck roughly, the silk comes off in burs, which will rise up to the guides, and obstruct the reel, instead of coming off singly. When a greater number of filaments are taken up by the whisk than are required, they are suffered to remain on it till wanted, a hook being provided on the reel to which it may be hung when not in use.

The cocoons are put in as fast as wanted, but no faster; for if they remain too long in hot water, the gum,

by being too far dissolved, causes the silk to come off unequally.

The filaments as they are wanted, are lightly thrown upon the thread that is winding, and being gently rolled with the thumb and finger, a union is effected. The skin of the fingers should be smooth, or made so by rubbing with sand paper.

It is of some importance that the water employed for reeling, should be what is usually called soft water, as this more readily dissolves the gum, and prevents the breaking of the filaments. It should be either rain water, water from slow streams, or from ponds.

If the water be too hot, the lustre of the silk will be injured, particularly of the white silk; so says M. Benezech in his instructions to M. Amans Carrier. Nay more; if the the water be too hot, the thread will prove *dead*, as it is technically termed, and without firmness. Therefore the proper temperature of the water is not of more consequence to the facility of the reeling, than to the good quality of the silk. But should the heat of the water be deficient, the ends of the filaments will not be well joined, and the silk will be harsh.

Sometimes the whole thread is broken by knobs obstructing its passage through the guides, or by an irregular and jerking movement of the reel. But in this case the silk must never be joined by a knot, it is sufficient that the parts be brought together, and united by slightly twisting.

Silk may be wound of any size, but it is difficult to unite more than thirty filaments in one thread. The art consists in preserving an even thread; a thing only to be attained by practice, since in the same cocoon the fibres diminish, growing continually finer to the end; and the united thread which is formed of three new and two half-wound cocoons, is considered equal to the silk of four cocoons. With the exception of the silk formed of two cocoons, other silks are not distinguished, other than as silk of three to four, or four to five, or five to

six cocoons. Those of larger size are not so nicely defined, and are called from twelve to fifteen, or from fifteen to twenty cocoons.

Whether twenty cocoons are united to form one single thread, or whether the same number of filaments are employed in the production of four skeins, provided both are wound with an equally even thread, the amount of labor is about the same in both cases.

The weight of silk which can be reeled in any stated time, depends on the activity of the reeler: there is a degree of dexterity required in adding fresh ends, for broken or expended cocoons, which can only be acquired by *practice.* Yet there are very few reelers who are capable of giving the requisite attention to three skeins at the same moment of time.

In the first establishments of Europe, as well as of some of the new ones in America, a steam pipe passes through the vessels containing the water in which the cocoons are immersed, preserving it at an equal warmth. These vessels are emptied at once by a cock at the bottom; and when the water becomes discolored, it is drawn off. Other cocks placed above furnish the supplies of either hot or cold water when needed. This water is heated by the boiler of the engine which turns the reels. It requires but little power to put in motion the reels of a vast filature.

SECTION XXXV.

DIFFERENT QUALITIES OF COCOONS.

THE cocoons designed for producing silk are divided by culturists into different qualities. Much more silk may thus be reeled in a day, if the cocoons are properly classed. The breaking of the single filaments arises from the use of ill formed or ill assorted cocoons, which require different degrees of temperature in the water into which they are immersed to dissolve the gum with which they are cemented in the ball.

Previous to reeling, the outer floss is separated. This is expeditiously performed by opening the floss at one end, when the hard, compact cocoon is readily protruded.

Cocoons are classed as follows:

1. *Good Cocoons.* These are firm, free from spots, both ends round, and capable of resisting the pressure of the thumb and finger. These are again subdivided, and the pure white are separated from the yellow of every shade. These last are indebted for their greater weight and yellow color wholly to the excess of gum which they contain. Pale cocoons preserve a better and purer white, and take a better pale blue dye.

2. *Pointed Cocoons.* These approach to a point at one extremity: they afford but little silk, and, after being partly wound, the filament breaks continually at the point, where the thread is always weak, and they can be reeled no further.

3. *Cocalons.* These are larger in size than cocoons of the first quality, but contain no more silk, being less compact in their texture. These are separated in reeling from other good qualities, because they require immersion in colder water; the fibres being more easily

disengaged from the gummy cement. By expert reeling, they produce silk of the first quality.

4. *Dupions* or *Double Cocoons.* These usually amount to not more than a hundredth part of the whole. These are reeled by skilful reelers, in water boiling hot, and usually without difficulty. These being formed by the united labors of two silk-worms, many of them are so intertwined that they break frequently in reeling, and sometimes they cannot be wound at all. The floss must be carefully separated, also any loose silk which may accumulate on the reel. The silk which these afford is not so fine as that of the perfect cocoon, but it serves to form sewing silk of the second quality.

5. *Soufflons.* These are very imperfect cocoons, the texture loose, even to a degree so great as to be transparent. These can never be wound, but by a particular process they are converted into *fleuret.*

6. *Perforated Cocoons.* These are the cocoons from whence the miller has escaped and are never reeled. Rev. Mr. Swayne was the first to discover that not a filament is broken but rather entangled. He has proved that half of them may be reeled. Yet it is doubtful whether it will ever be done to profit.

7. *Good Choquettes.* These are unfinished cocoons, or those in which the insect dies before the completion of their labor. On being shaken, the chrysalide is not heard to rattle, as it adheres to the side. The silk is as fine as that of the first quality, but it is not so strong nor so brilliant. They are liable to furze in winding, and must therefore be wound separately.

8. *Bad Choquettes.* These cocoons are defective or spotted: the silk which they afford is foul or bad, of a blackish color.

9. *Calcined Cocoons.* These cocoons are so highly esteemed, that in Piedmont they sell for half as much again as other good cocoons; but large parcels are rarely to be obtained. In these, the silk-worm, after having completed its labor, is seized with a peculiar disease, and becomes either petrified or reduced to a white pow-

der. They are known by a peculiar rattling noise when shaken. The quality of the silk is equally excellent, and the quantity even greater than that produced by the healthy silk-worms.

In reeling *good cocoons*, a thread composed of but five or six fibres, is said by M. Benezech to be preferred to one composed of eight. *Good choquettes* are seldom wound finer than from seven to eight cocoons at a time. *Dupions*, for ordinary sewing silk, are wound fifteen to twenty filaments to a single thread. *Bad choquettes* are usually wound from fifteen to twenty filaments to the thread. These, and other inferior cocoons, which are wound forty or fifty fibres at once, form a thread for the filling of coarse fabrics, or for sewing silk of coarser quality.

The water in which dupions and choquettes are wound, must be changed four times a day. But it is deemed sufficient that the water be renewed but twice a day, when good cocoons are reeled. Yet if the water is suffered to become foul, it injures the lustre and fine gloss of the silk.

In Cevennes, a district of France, famous for the excellence of its silk, the cocoons are not entirely wound off; as the latter part of the cocoon being exceeding fine, and abounding with knots, is liable to break. Therefore, in reeling fine silk, when seven-eighths of the silk is wound off, the cocoon is thrown aside and replaced by another.

These pellicles are occasionally taken out with a ladle and opened, and the chrysalide separated and thrown aside with that which was separated in the beginning, as of inferior quality; for these partly finished cocoons must on no account be permitted to remain in the basins, as they would thicken the water, and injure the color and the lustre of the silk, rendering it fit only for receiving the dark colors.

The high reputation of the silk of Piedmont is owing to regulations long established by law. Commissioners of the government who visit these establishments, impose fines on those who infringe these regulations. These

laws prescribe the size of the boilers, and the form and proportions of the reel, &c. &c.; and a quantity of silk less than five hundred pounds is not allowed to be reeled in a single filature. Hence the celebrity of Piedmontese silk.

However seemingly beneficial these restrictions and usurpations of the government of Italy may at first sight appear, yet their direct tendency is to create odious monopolies. The large and wealthy proprietors are benefitted at the expense of the cultivators, who being thus unjustly prohibited from the conversion of their own produce into the most profitable form for sale, have become paralyzed by oppression, and their industry languishes.

In France, where no such arbitrary restrictions exist, much less regularity indeed prevails; and silk is reeled by a variety of modes, some more or less defective, and of every quality. Here are innumerable domestic filatures; yet in some parts of France, particularly in the department of Gard, the produce of some of the filatures is considered nearly equal to the very best of Italy. Also in the upper department of Ardèche, there is produced a description of white silk of a quality so superior, that it is purchased for the lace manufacturers of Normandy, for more than 50 francs, or $9 20 a pound; but a few years since it commanded a price as high as 150 francs, or $27 60 a pound. Yet it is stated that with the exception of these filatures, and of one or two others which are destined to produce organzine by the proprietors themselves, there is little or none of the silk of France which possesses the desirable regularity of fibre which serves to distinguish the silk of Briance.

As to the cocoons which can never be reeled, the soufflons are boiled half an hour; the pierced cocoons which produce the best silk, are boiled longer. These are first dried, and then pounded to separate them from their chrysalides, which are reduced to powder. They are then opened by drawing them out at arm's length,

and placed on the distaff and spun. The silk thus produced is called fleuret. But if after boiling and drying, and beating, the cocoons are carded, the fleuret will be more bright and beautiful, and command a higher price, owing to the greater waste of materials, and the far greater amount of labor.

In every large establishment there should be supernumerary reels, to be detached from the reeling apparatus. When the suitable quantity has been wound on the reel, it is to be rubbed gently with a handful of clean coarse silk which has been dipped first in cold water and gently squeezed; it is afterwards rubbed gently and smooth with the palm of the hand. Then opening the windows, turn the reel with the greatest possible velocity for about ten minutes, which will effectually dry the silk.

DISBANDING THE REEL.

The individual fibres of which the silken thread is composed, will unavoidably suffer different degrees of tension during the process of reeling. This may arise from the inequality of the size of the filaments, or from their being unequally steeped in the water or from other causes. The fibres thus unequally stretched while wet, would be liable to contract, unequally, thus destroying the union and diminishing the strength of the compound thread.

To prevent such an occurrence, the skein must remain on the reel for six or eight hours, until the fibres are all firmly united in one compact thread. Those fibres which have suffered less strain in reeling, and those which have suffered a greater strain, will be brought to an equal length by the prolonged and forcible state of union which they undergo in the process of drying and shrinking on the reel. This drying must be effected in an airy place, but not in the sun.

When the skein is dry, tie a mark to the end of the

thread which might otherwise be lost in the skein, and become extremely difficult to find. First squeeze it together gently on the bars all around which will loosen it; then with a string of refuse silk, tie it on the place which bore on the bars of the reel; then carefully slide it from the reel and make another tie on the opposite end of the skein. After this it is doubled, and tied near each extremity, and laid by for sale or for use, in a dry place.

The value of silk when ready for sale depends on the absence of knobs and of knots which occasion it to be called *foul.* To judge if silk be *clean*, or free from imperfections, is an art very easily attained. It is only necessary to stand with your back to the window, and to open the skein, and looking down in the direction o the light, any foulness which may exist, is readily perceived by the practised eye. But the fineness of the thread is determined by a certain known admeasurement of the circumference of the reel and skein, the number of threads, and the weight. A given number, usually a skein of 400 revolutions, is removed from the reel and accurately weighed.

SECTION XXXVI.

FORMATION OF ORGANZINE, SEWING SILK, &c.

THE outside of the cocoon, which is formed of a loose furzy substance, constitutes one-tenth of the weight of the whole silk; this is called by the French, *fleuret;* to this is added all those threads called *waste silk*, which from want of skill, or defect in the cocoons, become broken in reeling, or doubling, or twisting. After being boiled in soap suds and combed, and spun on the spinning wheel, it is called *bourre de Soie*, or *filoselle*, or

by the English, *floss*. This floss is employed in the manufacture of gloves, mittens, and all kinds of silk hosiery.

The silk furnished by the cocoons is usually divided into six qualities. The 1st quality is called *Singles*—2d, *Organzine* or *warp*—3d, *Tram* or *woof*—4th, *sewing silk* of the first and second quality—5th, *Cordonet* or *twist*, and 6th *Filoselle* or *floss*.

Throwing or making Organzine.

Raw Silk, previous to weaving, must first be made to assume one of three forms, either singles, tram or organzine.

Singles are formed by the very simple process of twisting the raw silk, in order to communicate a greater degree of firmness to its texture.

Tram, or *woof* is formed by the twisting together, though not very closely, of two or more threads of raw silk, without first twisting them separately.

Organzine is used principally for the *warp*. It is formed by mills or machines constructed for this purpose.

In the formation of organzine, the silk is first wound from the skein on to bobbins or spools. These thus wound, are next sorted into different qualities. The thread is next twisted by the spindle after passing twice around an iron pulley, which is grooved in its outer circumference and two inches in diameter. This serves to regulate and compress the threads, and to give them a round form. Two or more of these threads are next united and twisted together in an opposite direction. Lastly, the different qualities of organzine thus prepared, are sorted according to their different degrees of fineness.

The gum serves the very important purpose of preserving the adhesion of the fibres of the silk until the whole is formed into organzine, or ready to be woven. After the organzining is completely formed on the bob-

bin, it is transferred into skeins of a prescribed length upon the reels. It is now called *hard silk*, and this name it retains until the gum is extracted. But were the gum extracted from the silk by boiling, before being twisted, it would become at best a downy or woolly substance, unfit for the purpose of manufacture. These observations have led us to doubt the utility of employing spirits of wine in destroying the chrysalides, inasmuch as pure alcohol may have a tendency not only to dissolve, but also utterly to destroy the tenacity of the gum; while pure water, in which the cocoons are immersed when reeled, can do no more than simply to dissolve the gum, without destroying its adhesive quality, which it recovers again when dry.

Previous to taking the silk from the reel, and to prevent it from crinkling in consequence of the twisting it has received, the reels are subjected to the action of steam for two or three minutes. This is a modern discovery which has been found effectually and permanently to set the twist. Formerly, the reels were steeped in boiling water, a troublesome and much less effectual mode.

The silk is now boiled for about two hours in a good proportion of water, in which soap has been dissolved in the proportion of one-third of the weight of silk to be prepared. This aids in dissolving the gum, and in rendering the silk soft and glossy. Particular care is necessary to prevent the silk from adhering to the bottom of the copper kettle, a circumstance to which it will be liable by reason of the viscid gum which is contained in the silk, which in this case will become carbonized and spoiled in that part. This though not always so perceptible at first, will infallibly be discovered when put into the loom, and will then cause infinite trouble.

After thus boiling, the silk is well washed in a current of pure water to purify and to free it from the soap; it is afterwards dried. It has now assumed that pecu-

liar softness of texture and brilliant gloss which constitute its principal excellence and beauty.

Raw silk usually loses from 2 to 7½ per cent. in weight, in the process of organzining; but after the gum is extracted by boiling, and after drying, the total loss usually amounts to 25 pounds in every hundred. But the waste varies materially in different filatures, and is greater in those of Italy than in those from Bengal. From the perfect system of reeling which now exists in the establishments of the East India Company at this place, the loss by organzining, sometimes does not exceed two per cent. on the weight of the raw material.

Sewing Silk.

Sewing silk is formed of two kinds, and four qualities; that only being formed of the best silk which is designed for sewing silk stuffs. The other, or second quality, is for sewing woollens, and for cordonett or twist. This second quality is formed of the dupions and of the ordinary sort of cocalons.

Mode of making Sewing Silk and Twist in Connecticut.

The following is the method followed in Connecticut, as recommended to the Secretary of the Treasury by Daniel Bulkley, Esq.

"The raw silk is first spooled on bobbins, the number of which is in proportion to the size of the intended thread from the first spinning; and to facilitate the operation, they are put into warm water. The silk is again spooled, taking two or three bobbins according to the size of the intended thread. After being spun, it is reeled into skeins, each of forty yards in length, or half a knot of the country reel, as required by a law of the State. About twenty-five of these skeins are put together, like a skein of cotton or woollen yarn They

are then boiled, adding a small quantity of soft soap, or ley of wood ashes, to cleanse them from the gum; they are then ready for dyeing.

"Silk twist is spun in the same manner, except that it is always of three cords. The winding of the twist is done on a machine imported from England.

"We have a small establishment for spinning by water, with a machine similar to a throstle frame of a cotton mill. The silk is first spooled by hand on bobbins, which are placed on the top of the frame, the thread of raw silk passing from it under a wire through a trough of water, then through rollers to the spindle. A single frame may contain from thirty to fifty spindles, and can be attended to by one person. The doubling and twisting may be done by the same frame at the same time, by giving the bands to a part of the spindles a contrary direction. As many threads are put to a spindle as are required to make a thread of two or three cords. Silk spun in this way is far superior to that done by hand. The machine will spin from two three pounds in a day. A pound of silk after being spun and cleansed, will weigh about ten ounces, and form one hundred and seventy skeins—the threads of sufficient size to sew woollens. If spun finer, it would make more. It increases little or nothing in weight when dyed.

"Silk is sold by the skein, one hundred of which will measure one-third more than half a pound of Italian or English silk, of the same sized threads. One woman can make from twelve to fifteen pounds of raw silk in a season of six weeks."

Brooks' spinning and reeling machine is highly spoken of. It was invented by Amos Brooks of Scituate, Mass., who has obtained a patent for the invention. They can be made with any number of spindles which may be desired, and may be purchased at the agricultural warehouses in our chief cities, at a price varying from $20 to $30.

The following description of Brooks' spinning ma-

chine, we copy from the Complete Farmer, a valuable agricultural work published at Boston.

"Brooks' silk spinning and reeling machine, which was invented by himself, is found to be a very simple and easy operating machine, and yet one of the most perfect that has been invented for the purpose of reeling and twisting silk from the cocoons, and manufacturing it into sewing silk. By the different arrangements of this machine, it will operate upon a single or double thread, as may be required, and prepare it for twisting or weaving. Experience has fully proved, that by uniting the filaments of silk as they are drawn from the cocoons, wet in their natural glutinous substance, before they dry, the thread is more firm, smooth and strong.

"The simplicity of the machine, and the very easy way in which it is used, brings it within the comprehension and capacity of any person to use it. Mr. Brooks has received a premium for his invention from several societies, and of late a premium and medal from Scott's legacy in Philadelphia."

Mr. Cobb has tried the invention of Mr. Brooks in his extensive manufactory for sewing silk; and although he highly approves of it as an invention eminently adapted for making sewing silk in families, yet for large manufacturing establishments, like his own, he gives a decided preference to the new and highly improved English machinery, for making sewing silk. We confidently hope that Mr. Brooks will add those improvements to his machine, which will render it as well adapted to extensive factories as it already is for the use of families.

Dennis' Reeling and Spinning Machine.

Jonathan Dennis of Portsmouth, R. I., has very lately invented and taken out a patent for a machine for making sewing silk, direct from the cocoon, at a single operation, which is stated by him to be far more perfect and expeditious in its evolutions than any other machine yet

known. Mr. Dennis ascribes the superiority of his machine over all others of American invention, to the superior speed and perfection of its movements; sewing silk of the most perfect quality being formed suddenly, and immediately from the cocoons, while the silk yet remains perfectly moist and flexible, and before the filaments become rigid and inflexible by dyeing, and therefore incapable from this cause of uniting so firmly and compactly by reason of the hardening of the cement or gum which they contain. Such are the statements of Mr. Dennis.

SECTION XXXVII.

PRODUCE AND PROFITS OF THE SILK-WORM AND OF SILK.

THE profits of a crop of silk may generally be indicated by the size and quality of the cocoons. If the cocoons are very large, like the products of the well cultivated and fertilized fields, it portends a profitable and abundant harvest. In regard to the produce, I would be always understood to speak only of good and profitable crops. Cocoons raised by Mr. Benjamin, in Bristol, Mass., in 1835, were so large that 160 weighed a pound. Those raised in the early settlements of Georgia, required but 200 to the pound avoirdupois; and of those raised by Mrs. Davenport, under the direction of Mr. Cobb, 206 weighed a pound. Cocoons raised by Mr. Stacy, in Burlington, Vt., 1835, required 214 to a pound. The weight of all these is very large. Count Dandolo found that 240 cocoons of his own raising, weighed a pound; but M. Bonafoux has averaged the weight at 256 to the pound. I have put down the average of a good crop at 250 to a pound, and Mayet has allowed the same number.

Cocoons are found to lose $7\frac{1}{2}$ per cent. in weight in

the first ten days, by the perspiration of the chrysalides. The proportion between the weight of silk which can be reeled, and that of the coarse floss which can only be spun, is found to be in the average proportion of 19 to 1 in perfect cocoons. But this does not include the outer floss, of a loose furzy texture, which can never be reeled.

1000 ounces of perfect cocoons have been found to produce 150½ ounces of pure cocoon. Thus every perfect ball, as soon as completed, contains more than one-seventh part of pure cocoon; but this includes the floss and the pellicles. I have stated the length of the filament at from 400 to 1200 feet, and others have estimated the length of thread equal to from 750 to 1160 feet. Count Dandolo states that the filament seldom exceeds 1875 feet. I have put down as the average length 900 feet. Mr. Pullen has stated the same.

Count Dandolo, by good management, usually produced at his establishment, 140 pounds of fine picked cocoons from each ounce of eggs, in addition to the coarse outside floss. But it has been found possible to produce 165 pounds of cocoons to each ounce of eggs, and by a late account, 170 pounds have been produced in 1835, by Henri Bourdon, proprietor at Ris, near Paris, and in the north of France.

It is estimated, from all the data that Europe has furnished, that 2,800 worms are required, on the average, to produce a pound of reeled silk. In 1790, the gold medal of the society for the encouragement of arts, in England, was awarded to Mr. Salvator Bertezen, for having raised five pounds of reeled silk from 12,000 silk-worms, which is 2,400 silk-worms to the pound of reeled silk. This average varies not very materially from the results produced by Count Dandolo. The cocoons in all the cases above stated must have been fine; and superior to those 8,000 cocoons from which Mr. Cobb obtained three pounds of silk, including the floss as is stated by him. Mr. Cobb is satisfied, that 2,400 cocoons to the

pound of reeled silk is not far from the truth, as even a less number he has found sufficient.

Mayet has stated, that ten pounds of cocoons of superior quality will produce a pound of reeled silk. At Cevennes, where the finest silk is produced, and where the cocoon is cast out, when seven eighth parts are reeled, but thirteen pounds of cocoons, of a thread of four or five cocoons, are required for a pound of the purest silk in the world.

Count Hazzi states, that seven to ten pounds of cocoons will make a pound of raw silk. In France sometimes even twelve have been required; while in America, eight pounds of cocoons will frequently produce a pound of reeled silk; and Mr. Cobb has stated that eight pounds avoirdupois yielded from sixteen to eighteen ounces of silk, six to nine cocoons to the thread.

In 1814, which was considered a season extremely unfavorable for silk-worms, Count Dandolo obtained fifteen ounces of very fine silk from 7½ pounds of cocoons, and from the same weight of refuse cocoons he obtained thirteen ounces. These instances shew the result of right management.

Let us look at the surprising fact which is stated by Judge Comstock, the author of the valuable "*Treatise on the Culture of the Mulberry Tree and of Silk.*" These cocoons were produced in 1835 by Mr. Lyman Atwater, of New Haven, and reeled at the factory of the Connecticut Silk Manufacturing Company in Hartford. Judge Comstock was on the spot. He states, that "from the books of the company, it appears, that from 34¼ lbs. of cocoons, nine pounds and three ounces of which were damaged, 6¾ pounds of silk were reeled. By this statement, it will be seen, that about five pounds of cocoons yielded a pound of reeled silk. "Part of the silk was reeled on Mr. Cobb's, and part on Mr. Dale's reel, by Miss Ann M. Benton, of Windsor, a very careful and skilful reeler." I can see no room to doubt a word of this statement. It will not therefore be deemed extravagant,

if, with good management, I allow a pound of fine reeled silk as the produce of eight pounds of cocoons.

Count Dandolo has stated, that twenty one pounds of leaves, with economy in feeding, will produce $1\frac{1}{2}$ pounds of cocoons. Again he has stated that, in Dalmatia, he has procured $1\frac{1}{2}$ pounds of cocoons from fifteen pounds of leaves. These several statements allow fourteen pounds and ten pounds of leaves, each and severally, to a pound of cocoons. This is from seven to ten pounds of cocoons to the 100 pounds of leaves. This quantity of leaves then appears to be sufficient to produce a pound of silk, with suitable economy in feeding and in reeling. But allowing for some waste, both in feeding and reeling, I will state 120 pounds of leaves as a good allowance for a pound of pure silk. Even 100 pounds of leaves were found sufficient by Mr. Tilloy.

The mulberry tree in France may be stripped of its leaves in the fifth or sixth year, or three years from the time of grafting, and the seventh year it yields leaves worth one shilling, or twenty two cents: and they go on increasing for twenty or thirty years, when the leaves bring thirty shillings, or $6 66. Large trees in the south of France will yield 300 pounds; by some accounts a great deal more.

The cost of cultivation is one franc, (18.4) per 100 pounds. The average cost of leaves in good years is three francs, or fifty-five cents per 100 pounds on the trees, in that country.

In some cases, the landlord finds eggs and leaves, and the laborers who make and reel the silk have half the profits. The reeling begins as soon as the crop is completed, and continues till autumn: and a woman experienced in reeling will reel two pounds of silk in a day of sixteen hours.

The pound of silk, when well reeled, is capable of being converted into sixteen yards of the ordinary quality of Gros de Naples, or into fourteen yards of the first quality, and worth its weight in silver.

The silk of Cevennes in France is probably the finest in the world. I have particularly stated the mode in which it is reeled, for to this cause, in a measure, it owes its celebrity. There is indeed one kind which is sold at Lyons for from $4 09 to $4 23, the English pound: but there is a kind still finer, which brings $8 88 a pound.

Four hundred thousand pounds of silk of superior quality was raised in Cevennes in 1832, and since that period, this quantity has been greatly increased; as among all employments of capital, none is so productive as the mulberry tree. It was yielding at the above period from fifteen to twenty per cent. profit to the intelligent agriculturist."

I have already spoken of a description of white silk which is produced in the department of the Upper Ardèche, which is of a quality so superior, that it is purchased by the lace manufacturers of Normandy for more than fifty francs, ($9 20) a pound. But a few years since, it commanded a price as high as 150 francs a pound, equal to $27 60.

Mr. William Carpenter, now of Lisbon, Conn., has manufactured silk at Spitalfields, in London, for twenty years. He is perfectly acquainted with the winding, warping and weaving of all kinds of plain silks, such as sarsenets, satins, gros de Naples, florentines and velvets; also figured silks, florets, tissues and damasks, all which required very different kinds of silk; he must therefore be considered a competent judge. He has also, according to his statement in the "*Silk Culturist*," woven many pounds of silk of *American growth:* and he has seen many samples of American silk, far superior to the Bengal, China and French silks, and nearly equal to the best Italian. He has known Italian silk to be sold at a dollar an ounce in England before it was manufactured; and the average price is about seven dollars a pound. At the present time, says Mr. Carpenter, the most inferior kinds of manufactured silk imported from

England, France and China, are sold in this country for sixteen dollars a pound. And, as the cost and fair profit of manufacturing cannot exceed seven dollars, it leaves the enormous profit of nine dollars a pound for the raw silk, which price the Americans are now paying to the people of Italy and France.

SECTION XXXVIII.

PRODUCE OF LAND, OF LABOR, AND OF SILK.

I have stated that Mr. Duponceau raised in the city of Philadelphia seven ounces of eggs with the labor of two persons, and those not fully employed, except the last ten days, and some occasional help, who were employed to bring the leaves from the country, two miles distant. Such is the statement of Mr. Cobb. G. B. Smith, Esq., a gentleman practically acquainted with the business, and one on whom we may rely, has assured us, in his publications, that "the labor required to attend 1,000,000 silk-worms would be, the first week, two persons; for the second, four; for the third, eight; for the remaining two, fifteen or twenty." Most of these may be girls, boys or aged women. The aggregate amount at *the most*, according to this estimate, will be but 378 days of individual labor.

In Connecticut a child of from nine to twelve years of age, will gather seventy-five pounds of leaves in a day, this being called a day's work in that State, where the trees are usually large and difficult of access; and it is also stated that there, one hundred pounds of leaves will produce one pound of reeled silk. And a child in six weeks, or thirty-six working days, will gather at this rate, sufficient for twenty-seven pounds of reeled silk. It will readily occur that from low plantations of trees,

in prime condition, a much greater amount might be gathered with the same labor.

In the "*Silk Culturist*," a valuable periodical published at Hartford, by Judge Comstock, is the statement of Mr. Harvey Clark, who we well know is a highly respectable citizen of Mansfield in Connecticut. This account is valuable as showing the *amount of labor and attendance*, and of gathering the leaves from *tall trees*, and of *reeling*.

Mr. Clark has annually made thirty-five pounds of reeled silk from trees forty or fifty years old, and covering half an acre, all the labor of gathering the leaves and attendance, during the first three weeks, being performed by Mrs. Clark and a young woman who lives in the family. After the first three weeks, Mr. Clark devotes himself entirely to the business. The silk has been reeled exclusive by Mrs. Clark and the young woman, at the rate of a pound and a half a day. During the whole silk season they have had the care of eight small children. Mr. Clark states that no fire is ever used in the apartments of the silk-worm by him or others, in Mansfield.

The communication of M. Amans Carrier, a silk culturist in Aveyron, in France, to M. Bonafoux, director of the Royal Garden of Turin, is from the "*Farmer's Register*." In this particular account of the profit of a silk crop much is ascribed to the perfect mode of reeling, and full credit is given to aid derived from the counsels and assistance of M. Marchetti, an Italian and political refugee, and a skilful *filateur* of silk. The crop was raised in 1833, from trees which had been planted eight years, on less than half a *hectare* of land—or one and a fourth English acres.

The produce was as follows:—

25½ kilograms white silk at 63 francs the kilogram,	1,830*f.*	60*c.*
2 11/12 inferior silk at 18 francs the kilogram,	44	95
Deduct for Portage,	16	00
	1868*f.*	55*c.*
Value of the different remains coming from the remains of the filatures,	115	00
Sum realized,	1938*f.*	55*c.*
For expenses of management,	171*f.* 75*c.*	
For the filature and reeling,	263 85	435 60
Profit,	1548*f.*	95*c.*

The kilogram is 2 lbs. 2 oz. and 4 gr. avoirdupois—the produce of an English acre and a quarter amounted to 69⅓ pounds, and the amount of sales $350, or about $5 per pound. The net profit also after deducting all expenses, will be found to be $280 or more to the English acre from a young plantation. The number of trees is not stated in this account.

I shall close this section with a calculation, and estimate, which has been formed with very particular reference to the best informed in America.

Mr. D'Homergue in his letter to the Hon. Andrew Stephenson, Speaker of Congress, has indeed stated, that 3000 mulberry trees set on an acre of land, will produce in seven years a crop of leaves of 90,000 lbs. in a season, sufficient for 7,500 lbs. of cocoons. Again the "Massachusetts Journal" of 1828, Vol. x. page 137, says, that "a single acre planted with mulberry trees will produce from five to six hundred pounds of raw silk."

Yet while I admit that the statements of M. D'Homergue and the Massachusetts Journal may be very much overrated, I must also speak of the statements of Messrs.

Clark and Carrier as the counterpart. Both of them will be found to fall very far short of what we may in truth accomplish in our climate, if we do but proceed aright.

The plan of forming plantations with the mulberry trees at an extended distance asunder, I reject, as inconsistent with economy—when we consider the prolonged outlay, and the delay of the forty years which may be necessary completely to cover the ground, with trees of enormous size, difficult alike of management and of access.

A *Dwarf Mulberry tree plantation*, of a single acre, with the trees set in rows eight feet asunder, and two and a half feet apart in the row, will contain 2160 trees; each tree at six or seven years of age, with the best of cultivation, will produce, as has been estimated, ten pounds of leaves in a season. And ten pounds of leaves yielded by each single tree, will produce 250 cocoons—or the 21,600 pounds of leaves which are produced on an acre, will yield 540,000 cocoons—and 3000 cocoons will produce one pound of *reeled* silk, which will make the amount equal to 180 pounds, to the acre—or a plantation of 100 acres will yield 18,000 pounds of silk, and this silk, when *well reeled*, at the very low estimate of four dollars a pound, would bring $72,000 gross amount per annum; but an acre composed of but half this number of trees, set five feet apart in the row, might require full nine or ten years to produce this same quantity.

If any there be who might suspect that I had estimated the quantity of green leaves, the produce of an acre, at six or seven years of age, *too high* at 21,600 pounds, I might refer them to the estimate of Mr. D'Homergue, and perhaps some others, who have calculated the produce of the leaves of an acre of mulberry trees of seven years of age, at *more than four times the amount* which I have stated.

Let it also be noticed, that in allowing ten pounds of leaves for 250 cocoons of the *size* I have named, I may

have allowed *largely*, as this is 120 pounds of leaves to the pound of reeled silk. Even 100 pounds of leaves to the pound of reeled silk has been found sufficient, with economy in feeding, as Count Dandolo and others have proved. See also page 111, where in M. Tilloy's experiments, and in each of the two cases, but fifteen pounds of leaves were required for 500 silkworms. My estimate is founded on the calculation of a *single crop of leaves only*, during a whole season. But in our favore climate and with our prolonged summers we must calculate on successive crops in a season; on more than one single gathering, or harvest.

This is the calculation of the produce of an acre of *young* trees of six or seven years of age; but an acre, in its prime, must produce an amount much greater. According to Count Dandolo, 198 pounds is estimated as the produce of an acre of *large trees*. Citizen Genet, of New York, and formerly the Minister of France, has made an estimate of the produce of an acre in *hedge form* at 666 pounds. Mr. Daniel Bradley, indeed, considers that 1,000,000 silk worms may be fed from the acre of hedges *in its prime*. I had arrived at the same conclusion, and believe this estimate cannot be very far from truth.

I have stated that 3000 cocoons would produce a pound of fine reeled silk, consequently 1,000,000 cocoons would produce 333 pounds. I have also in the beginning of this section put down the days of labor, on good authority, at 378 for this number of silkworms. According to these statements, it will be easy to calculate the nett profit which may be expected from 1,000,000 silkworms. If the silk is reeled well it will bring $4 a pound, making the whole amount of $1332 as the produce of an acre of trees in its prime. But if reeled as at Cevennes, it will bring a great deal more. From this gross amount we must deduct the labor, which at 75 cents a day will amount to $284, a high estimate for the labor when we consider it is so easy as to be chiefly

performed by females, and by girls and boys. Yet this will leave a balance of $1048 as the nett produce of an acre of land in its prime estate.

I have said nothing of the expense of reeling, from a perfect confidence that the bounty offered in several of the States, including Massachusetts, Connecticut and Vermont, would be sufficient to pay for *reeling it well.* This bounty will vary from fifty cents to eighty cents a pound. I have also stated that in France a woman will reel two pounds a day, and *reel it well;* or silk of that quality which when manufactured is worth $16 a pound. Of other silk, or that which is reeled of two or three, or four to five cocoons, a woman experienced may be able to reel with perfect ease but a single pound a day. But such silk, as I have elsewhere shewn, will command an extraordinary price.

But the State of New Jersey, and the great State of Pennsylvania, have offered bounties, equivalent to $2 a pound, for every pound of silk which shall be raised and reeled within those States; and this bounty is to continue for five years. And inasmuch as the whole cost of raising and reeling, has been estimated by good judges, as not exceeding $2 a pound, it is evident that the whole value of the silk must be clear gain to the grower, after he has received the bounty thus liberally offered by those States. Hence the mighty and extraordinary impulse which the silk business has of late received. Other States also contemplate the offer of similar bounties.

SECTION XXXIX.

DIVISION OF LABOR.

The cultivation of the mulberry tree, and the raising of silk, may each with advantage be conducted as separate branches of the same department. The avenues of the mulberry tree on the plains of Reggio, with the habitations for the insects which are on either side, are the property of wealthy citizens who reside in Reggio; these furnish to another class the leaves, and every necessary requisite, receiving in return two-thirds the product. At other places, as in France, the profits are sometimes equally divided. In France, also, the plantations of the mulberry constitute in many places a part of the real estate of the landed proprietors, the leaves being annually sold on the trees. And a gentleman who has resided many years in France, informs us of one plantation of five thousand young trees, which, when well grown, it was computed would bring annually one dollar each for a single crop of leaves. In that country, whole families, at the suitable season, find employ in gathering the leaves, as an exclusive occupation. The reeling may also form a distinct branch, although it is intimately and generally connected with the culture.

Though there are silk factories in Italy, yet the greater part of their fabrics are of domestic manufacture. The manufacturer, after having purchased the silk of those who raise it, and after it has been reeled in the manner best suited to the fabrics he desires, prepares it for the loom, by dyeing, warping, &c., and then puts it out to the weaver, who weaves it in a hand loom. The weaving is performed by both males and females. It is then finished and put up for market.

Not only in Turkey, but also in many parts of Italy and France, the leaves of the mulberry are sold in the

market by weight, to those who make it their business to rear the silkworm in cities. But judgment is required by the purchaser in the selection.

In other places, the trees are hired by the season, the price paid being from four to six francs for each tree, according to its size and condition. In France, a well cultivated tree will usually produce thirty pounds of leaves, but in the south of France there are many trees which will produce some 150 pounds, and some 300 pounds of leaves, and some trees produce even more.

SECTION XL.

REMARKS ON THE PRICE OF LABOR.

It has been remarked by the Baron Charles Dupin, who is deemed high authority, for sagacity and distinguished research into all subjects connected with questions of commercial and political interest, that in all the most important branches of manufacture, a superiority the most decided, has been attained by those people with whom labor bears a higher price than with their rivals. He instances in proof the cotton manufactures of England, which are afforded both cheaper, and of better quality, than by any other people of Europe, although the price of labor is dearer in Great Britain than in any other country of the Eastern World. Also, he instances the manufacture of linens, in which the Dutch and the Belgians surpass and undersell the Bretons, although the price of labor is higher in Holland and in Belgium than in Brittany. Furthermore, he has shown that in the production of fine woollens, France surpasses and undersells Spain, although the price of labor is higher in France than in the latter kingdom.

The striking superiority, in these instances, is ascribed

by him to higher attainments in mechanical ingenuity and skill, and a more eminent degree of commercial knowledge and enterprize.

The curious machinery for forming organzine, which for a long period existed only in Piedmont, was introduced to England, in 1718, by Sir Thomas Lombe, who established vast mills at Derby. At the present day the machines for throwing silk are wonderfully improved; cast iron geering being now substituted for the cumbersome wooden wheels, and metallic bearings having superseded the shoulders of wood, the rough wrought iron spindles being now replaced with those of steel accurately turned; and with diminished power the spindles of the English now revolve with more than four-fold speed. So decided is this superiority, that while the throwsters of France and Italy are still contented if their spindles do but revolve from 300 to 400 times in a minute, those of the English are now performing from 2000 to 3000; but by a late improvement of Mr. Ritson, they are now made to perform 4500 revolutions in a minute or 75 in a second of time.

On a careful investigation it will usually be found that the apparent difference in the price of labor between different countries, is in many cases rather nominal than real; and that in those countries where labor is highest, in regard to price, there the greatest encouragement is always offered for the exercise of the ingenuity of man, in curtailing and diminishing its amount in every possible mode. Sufficient and ample evidence of this important fact is taking place daily before our own eyes, and in our own country.

Every experienced farmer and artizan well knows that low priced labor is far from being the most profitable to the employer; the very reverse of this being usually true; the cost of board being equal.

In the old world, lands are very dear, and their cultivation to a very considerable extent, is effected by manual labor. The poor, by various acts of oppression

invented, are constrained to labor at a very low price. With us lands are comparatively cheap, and are mostly cultivated by animal labor. The cattle which roam on our boundless prairies and pastures, and on the innumerable hills, afford us aids which will enable us to compete with any nation on earth in every production of field cultivation.

Our prairies and plains are now mown not unfrequently by revolving scythes attached to a horizontal wheel, or by scythes having a lateral movement, and moved forward by the power of horses, and a horse rake collects the winrow. Our fields of wheat are not unusually reaped by machines propelled by horses, and afterwards threshed by the same power.

The exhaustless treasures of the forest and of mineral coal, offer resources unknown. The innumerable rivers and rapid streams afford us perpetual and immeasurable resources of labor saving power.

In China and in India, where the price of labor is exceedingly low, their looms are moved exclusively by muscular power and human strength; it is much the same in Italy. Yet however low the price of wages in those countries, the poor weavers of China, and of India, can never compete with our *power looms* for cotton and for silk, by which common cotton is now wove for less than a cent a yard. Even a poor and precarious subsistence alone they could never obtain, in the desperate conflict with our engines, moved as they are by the resistless powers of water and of fire.

In France, the wood growers, and the mines of iron, and iron works, are protected by laws. These are generally the property of the rich. Of a population of 32,000,000, but 170,000, or about the proportion of 1 in 200 are allowed to vote. These are the rich, and, as might be expected, the poor are oppressed by dreadfully disproportionate taxes. At Lyons, the taxes for town dues of the laborers are heavy, amounting to fifty-four francs per annum in 1835, from their scanty earnings.

But the silk manufacture is *not protected*, except by a small duty on imports of manufactured silks, of from fifteen to seventeen per cent. It is fostered by the good taste of the people; it is therefore the only trade in the kingdom which is never in distress. In matters of taste, and in the formation of the most beautiful figured patterns in silk, the taste of the French controls the world. The mere handiwork, or execution of the weaving, of the most curious pattern, is a simple affair with the *Jacquard Loom*. Every establishment at Lyons has one or more artists, and artists schools are established at Lyons. It is the cultivated taste of the nation, so celebrated for excelling in all that is fine in the arts. New patterns are formed in the imagination by new combinations of flowers gathered from the field and tastefully arranged. From these the pattern is drawn. The botanist, the florist, even every weaver exerts his skill.

It is true, that in France there are no taxes imposed on the mulberry tree, but there is a general land tax. In Italy the mulberry trees are taxed.

In France, as many women as men are employed in their silk manufactories. This practice was introduced from necessity by the conscription laws of Napoleon. In China a great proportion of the operatives in the silk manufactures are females, according to Staunton. In Italy the weaving is done by both males and females, and much in the domestic way, as much of the plain weaving is now also done in France, and in India, and China, and all other countries where the silk is raised.

In those countries, two persons are required at one reel. Throwing mills which are moved by water, there are, indeed, it seems in Italy, but the operatives, who are mostly females, are prejudiced against machinery, and do most of the work by hand.

The celebrated philanthropist Montesquieu was opposed to labor saving machinery; this only proves that Montesquieu was theoretical rather than practical, and

is excusable only considering the age in which he lived. The doctrine that labor saving machines are injurious to community, is the doctrine of despotism. It is the principle that one portion of the human race were formed exclusively for labor, that another class might live in indolence and effeminacy.

When the *power looms* for weaving cotton were invented and introduced to practice in England, they were at first opposed and put down by the anarchists and infuriate mobs. Who has not heard of the mobs of Birmingham, of Manchester, and of Spitalfields, on every occasion when new and very important machines were invented and attempted to be introduced for the saving of labor. It is otherwise now. *Power looms* for weaving plain silks, have certainly, years since, been invented in England; but we believe they are little adopted in practice from this only cause.

In the single hand ribbon loom, the weaver could make but a piece and a half a week; but with the engine loom, six pieces in a week are now made. Five shillings for each piece of ribbon wove, was paid to the engine loom weavers, in the winters of 1831–2, yet it is stated that these looms were not common, owing to the prejudices of the workmen. Nothing, in fact, but the pressure of Swiss competition, has forced this loom into use in England and in France.

The bar loom for weaving ribbons, was a Swiss invention, by two brothers of St. Etienne. For this they were persecuted by the ribbon weavers, and driven with execration to the depths of misery. The last died not long since in an hospital, the victim of abuse and neglect. Glad were the weavers of this very district, of late years, to adopt this loom, which has now become their favorite mechanism, and in almost universal use.

The inventor of the beautiful and famous mechanism called the *Jacquard loom*, was originally an obscure straw hat manufacturer, M. Jacquard, who had never turned his attention to mechanics. For this he received

the patronage of Napoleon, and was rewarded by him with a pension of 1000 crowns. It was not, however, but with extreme difficulty, that he was enabled to introduce his machine into use with the silk weavers. Thrice was he exposed to imminent danger of assassination, until finally, the *official* conservators of the trade of Lyons, broke up the loom in the public square, and the several parts being sundered, the iron was sold for old iron, and the wood for wood, and the name of the inventor of the famous Jacquard loom was consigned to universal hatred and ignominy. Nor was it till the French began to feel the resistless force of foreign competition, that they recalled to their aid the admirable invention of their countryman, as their only shield and protection.

The absurdity of the dogma of Montesquieu and some others, that the labor saving power of machinery, is productive of no permanent good to community, is beautifully illustrated in the following description of the comforts of an Italian silk mill, by an able modern traveller. I have introduced it from the work of Dr. Ure, and it was extracted by him, from "*Mrs. Jamieson's Diary of an Ennuyee*," p. 82.

"There were vast groves of mulberry trees between Verona and Padua; and we visited some of the silk mills, in which the united strength of men invariably performed those operations which in England are accomplished by steam or water. I saw in a huge horizontal wheel, about a dozen of these poor creatures laboring so hard, that my very heart ached to see them, and I begged that the machine might be stopped that I might speak to them; but when it *was* stopped, and I beheld their half savage, half stupified, I had almost said, half brutified countenances, I could not utter a single word, but gave them something and turned away." Such is the account which this lady has given us.

Silk is an absorbent, and will absorb ten per cent. of

moisture. The temperature and the state of the atmosphere have a great effect on the filature and spinning of silk. Both are favorable in Piedmont. Our own climate is equally favored from the same causes.

Our lands are fertile, abundant, and cheap, compared with those of all other countries where silk is cultivated. No doubt can exist, that the new plant, so remarkable for the vigor of its growth, and the promptitude with which its foliage is renewed, will afford the needful succession of food for a two fold harvest, thus at once being productive of a saving of half the land and half the labor of cultivation. The leaf also, from its superior quality and size, will afford a saving of half the expense of gathering the food.

By cultivating the mulberry tree in hedge rows, it is estimated that the ground will, in a short space of time, produce a double amount of food which can be obtained in any other way. And it is also estimated that any equal amount of leaves may be gathered from the trees in hedge rows, at one half the labor and expense which would be required from standard trees. The hurdles of netting on which the insects may be fed, it is computed will be productive of a very important saving of time, and of labor, which is usually bestowed on the insects.

By the aid of water, or of steam power, we shall be enabled to dispense with the labor of a girl to turn the reel, which will be productive of another very material saving; and finally, by the aid of power looms, which have been recently introduced for weaving plain silks, it is confidently affirmed that a woman experienced in weaving, will be enabled to weave fifty yards in a day.

SECTION XLI.

USES AND FABRICS OF SILK.

VELVET. One of the richest and most beautiful fabrics of silk is *velvet.* This, however, is comparatively of modern invention in Italy. But the most beautiful are now produced in Germany, and latterly in England. The plain silks are variously denominated.

Persian Sarsnets, Gros de Naples, Ducapes, and a great variety with other names, belong to the class of plain silks, and differ only in the thickness of the fabric, or in the quality of the materials which are used in the manufacture. *Persian* silk is extremely flimsy in its texture, and has been nearly superseded by sarsnet. *Sarsnet,* which formerly constituted the main materials for garments, is now chiefly employed for lining them.

Gros de Naples is now used to form the substance of garments, and for this purpose has taken the place of the former qualities. It is stouter and harder thrown, and is woven with greater care and labor, the threads made more close and compact. *Ducapes* are also stout, plain wove silk, but the texture is softer than Gros de Naples.

Gauze is a very thin, light, transparent substance, much used for veils for more common use. It is supposed to derive its name from Gaza, a city near the confines of Egypt, in Palestine.

Silk Damask is a stout, compact, twilled fabric, usually of one color, but of a variety of figured patterns. It was formerly employed for garments, but its use is now principally confined to ornamental furniture for the decoration of houses and of churches. The manufacture is supposed to have come from Damascus.

The French have long had an imitation of Damask called *Cafard,* or counterfeit, which was formed, the

warp of silk, but the woof of linen, woollen, cotton, or even of hair. Similar imitations come from India, and possessing a good degree of beauty, are much used at the present day.

Satin is a twilled fabric, of a peculiar description, seven-eighths of the warp being kept floating on the surface, and exposed to view. The beautiful finish and lustre is communicated by passing it through heated cylinders.

Crape is a light, transparent article, woven plain, but prepared by a peculiar process in a mill, and stiffened by a gum.

The elegant figured silks, of a vast variety of patterns, are now woven by the curious machine of M. Jacquard, with a wonderful saving of labor and of time.

The surfaces of plain silks are now embossed by being passed between two metallic rollers which are exactly fitted to each other, and in one of which the intended pattern is sunk in the cylinder, and in the other cylinder it is raised. This process is extensively employed for ornamenting ribbons, vest patterns, &c. The effect is extremely tasteful and beautiful. One of the cylinders is hollow, for the purpose of introducing a red hot iron.

Many substantial and beautiful fabrics are formed of a combination of silk and worsted. *Bombazine* is formed of silk and worsted, generally woven grey and dyed afterwards. Other beautiful varieties are formed of silk and cottons. Varieties of vestings, varieties of heavy damask, concan, seersuckers and other fabrics from India and China, also elegant imitations of figured silk for ladies' dresses, are now formed in France of cotton and silk. Very beautiful hats are now formed of felt, with the covering of silk plush, which can hardly be distinguished from the finest beaver, to which they are so far superior that while the latter is extremely liable to lose its color and lustre, becoming *rusty*, the hats formed of silk retain their glossy jet black for a double length of time.

Silk either constitutes the chief material, or enters into the formation of almost every article of wearing apparel, on account of its extraordinary strength. Its uses are indeed almost infinite.

Much silk is used in the habiliments and equipments of armies;—much is used in the splendid decorations of our halls and especially of our churches.

Well reeled silk, it is stated on good authority, brings a higher price, even than the sewing silk of Connecticut, and the waste of materials is comparatively nothing. How important then that the silk should be well reeled; when even the bounty of fifty cents per pound which is now offered by the Legislature of Massachusetts, for every pound of silk which may be reeled within the Commonwealth, will soon be pay sufficient to enable a woman to reel it well. Connecticut too has offered a bounty. Other States also have, as I have already stated, offered bounties for five years, of two dollars a pound, for the raising and reeling, which it is believed is a sum fully adequate to pay not only the expense of reeling well, but also of raising the silk.

Silk is a hygrometric substance, as it will absorb as much as ten per cent. of moisture. In case of suspicion of fraud, the silk is enclosed in wire and exposed to a gentle stove heat equal to 78 deg., and afterwards weighed, till it loses not more than 2½ per cent. a day; this is the practice in France. Silk is of a nature imperishable in a remarkable degree. It has been dug up from graves and the subterraneous mansions of the dead, where it had lain buried for years, and found entire and uninjured.

SECTION XLII.

SUCCESSIVE CROPS OF SILK.

From the present encouraging appearances, we are induced to believe, that instead of one single and solitary crop of silk in a year, we may yet be enabled, in

our climate, and with our prolonged summers, to raise not merely two crops of silk a year, with a void interval of time between them, but numerous crops of different ages at the same time and in rapid succession for a season. With the complete establishment of such a system, a new era with us will commence. I have called this *The American System*, because this is the system which seems best of all adapted for America. There are mulberries which in our climate will renew their foliage suddenly, and for numerous successive times in a season. The trees will bear stripping twice and even thrice in a season, which is not the case with the white mulberry, even in a good portion of Italy. Where a regular succession of crops can thus be obtained, with a diminished proportion of labor, of land, of cultivation, of habitations and of furniture, for the successive generations of insects, how greatly augmented must be the profit.

Some, I am aware, might object, on the supposition that the plan has been before tried a hundred times in Italy, in France, and other countries. Not a doubt exists but it has been tried; but we have no evidence whatever that in a suitable climate it has ever been tried fairly and aright and failed.

Count Dandolo has indeed advanced the opinion that in Italy it is disadvantageous to obtain more than one crop in each season. He affirms that in that climate the mulberry tree cannot bear the continual stripping of its leaves without injury. His remarks however must have reference exclusively to the *white mulberry*, since the morus multicaulis was not known in any part of Europe at the time his celebrated work was written.

In the latitude of Paris, from the latest information which I have just received from that country during the past year, it is confidently affirmed, on high authority, that by the acquisition of the Chinese mulberry, a doubt no longer exists that two crops of silk may be obtained in a season, even in the northern departments of France, where never more than a single crop could be obtained

before. Neither could the remarks of Count Dandolo have had reference to other climates. In Malta the mulberry makes twice the growth that it does in Italy; but in India, its growth and verdure are perpetual.

On the authority of Monsieur Nollet, in Tuscany, Italy, and especially in the country around Florence, the same number of silk-worms are reared, and the same quantity of silk is produced on half the land and half the number of mulberry trees that are required in Piedmont. The silk-worms being hatched at two distinct periods, the first brood are fed upon the first leaves of the spring, and these having passed through their various evolutions, other eggs are hatched, and the insects are nourished from a second crop of leaves from the same trees.

The same plan is adopted in China, where two crops of silk are raised in the year. In some parts of India, and other parts of Asia, eight and even twelve broods of silk-worms are reared during the course of the year. In the Isle of France, Monsieur Chazal reared three successive generations between the months of December and May. There, as well as in India, the mulberry is an evergreen tree, affording fresh leaves, and a continual succession of food throughout the year.

Some assert, that the silk-worm of Tuscany is of that particular species, which is called the "*Two Crop Worm*"—or the "*White Worm*",—which, having produced one crop of cocoons, the chrysalis perforates its cocoon, and the miller lays its eggs, which produce a new generation in the same season. Besides the common silk-worm, which produces but a single crop in a year, they have also, at Jungepore in India, the *Dacey*, a silk-worm which produces eight crops. I have described them both.

I have stated that, in Tuscany, also, so fine is their climate, that two crops of silk are annually produced. The same has been effected by Mrs. Parmentier at Brooklyn, on Long Island. The first crop being fed from the *morus multicaulis*, *morus alba*, and other mul-

berries promiscuously, were of different colors, some white, and some of an orange color. But a second crop of worms from the same cocoons, being fed exclusively on the leaves of the *morus multicaulis*, finished their labors in the short space of twenty-six days from the commencement, which was about the thirtieth of July. This last circumstance might be, in part, owing to the warmth of the season. The cocoons thus produced were not only of larger size than those of the first crop, but what is still more important, they were beautiful and shining, and of the *whiteness of snow.*

At the Fair of the American Institute of New York, in 1833, cocoons were produced of two successive crops of silk. The first crop were hatched the 11th of May, the second crop the 8th of July, and a third crop might have been produced. All being fed on the *morus multicaulis*, they were of a snowy whiteness. In the same year, Mr. E. Stanley, of Ogden, N. Y., produced two successive crops, the second was hatched by accident, and the cocoons were fine. In Brattleboro', Vt. in the same year, two successive crops were produced from the common white mulberry. And in 1834, as Dr. Holmes has recorded, *two* crops of cocoons, both of them large and perfect, were produced in Winthrop, Maine. See his account in the *Maine Farmer*, vol. iii. Feb. 20, 1835, published at Winthrop.

In all these cases, the second crop of silk-worms was produced from the eggs from the cocoons of the first crop.

Dr. Millington, of St. Charles, Missouri, has tried the experiment with the most satisfactory success. He is an eminently practical, scientific agriculturist, who has made silk one of the principal objects of his attention for several years.

In his valuable communication in the American Farmer for January, 1829, he has stated, that the eggs of the same year hatch but partially, or do not hatch so regularly and simultaneously as those of the former year. He notes the date and the day the eggs are produced,

on the papers on which they are deposited; and those eggs of a similar age are brought forward to hatch at the same time, and then they usually are all ready to spin together. If all the eggs are saved from the first crop, it will prevent the possibility of degeneracy. These are carefully rolled up and preserved in dry boxes, and kept in a dry cool cellar, and in June or July of the following year, and when the heat of the climate or season requires it, they are transferred to a dry ice house.

Among the great advantages of having silk-worms of different ages in the same apartment, he asserts, "that the same room and shelves will hold abundantly more worms at the same time without being crowded; and a room and shelves which will but barely accommodate 100,000 full grown worms, will better accommodate 250,000 consisting of four or five different ages, provided each age or parcel are about equal in number, and are hatched seven or eight days apart." Also it is ascertained that, by this system, much more can be done with the same amount of labor, than by any other mode.

I am perfectly aware, that the excellent Dr. Pascalis, at the time he published his work on silk at New York, in 1829, endeavored to explode the idea of attempting to raise numerous crops, or even two successive crops of silk in a season. He states some plausible reasons for his objections, particularly the record of the failure of an attempt near Lyons, about 1820; and also the failure of the attempts at the Isle of Bourbon, situated beneath a fiery sun, and within the burning zone. In the next year, and in No. 2 of his valuable work, "The Silk Culturist," for January, 1830, Dr. Pascalis has recorded the successful introduction of the silk culture to the *north of France*, a thing which had been deemed, at least, equally problematical thirty years before. Also, that Dr. Deslongchamps, had even succeeded in raising a second crop of cocoons from the eggs of the first. Dr. Deslongchamps was one of a society of *savans*, at

Paris, who had performed many experiments to prove that this branch of industry can be successfully carried on through all the northern departments of France. He also had ascertained, by experiments at Paris, that the cocoons which were produced by silkworms fed exclusively on the *Morus multicaulis*, were even rather heavier than other cocoons. The more complete and effectual conversion of Dr. Pascalis to the system, does not appear so fully until afterwards, when speaking of the *M. multicaulis*, which he had received from France, he avers, that, "after the discovery of this plant, a doubt no longer exists, that two crops of silks may be produced in a single season."

SECTION XLIII.

MODERN SYSTEM OF COUNT DANDOLO, OF ITALY, AND OF FRANCE.

THE specimen house of Mons. Matthiew Bonafoux, of Piedmont, the disciple of Count Dandolo, though calculated for 160,000, yet in this instance it contained but 80,000. The house is isolated and exposed on all sides. It is by the side of a brook. It is twenty feet square in the clear, of course the same in height. Around the four walls, at ten feet from the floor, there runs a frame gallery, which facilitates the attendance of the nursery in all its parts. There are five windows and thirteen ventilators through the walls, so disposed as to admit fresh air on all sides. These last are a foot square, more or less, and furnished with slides; and seven ventilators in the roof to open with cords. There are two stoves in opposite angles, each with an air chamber for heated air; also a fire place in the side with a broad hearth, for fires of light blaze, or flame fires. There are forty hurdles, each fifteen feet long and three feet wide, sufficient for four ounces. Oppo-

site the principal door is a small house in two apartments, one of which is for the attendants, and the other for preserving the implements, and also used as a hot house for hatching the eggs.

There are various implements and furniture which I shall not describe. A *Hygrometer* for ascertaining the moisture; but a saucer with some half pounded salt will shew the amount of moisture. Excess of moisture is rectified by the stoves, or by flame fires. The *Thermometer* regulates the heat within, which in the beginning is 75° but is lowered gradually to 63° in the last days, though the weather is constantly growing warmer. Also a *Fumitory*, or large bottle containing seven ounces of sea salt, three ounces pulverized manganese, and two ounces of water; a large spoonful of oil of vitriol being added causes an effervescence, which neutralizes the bad smell, or miasma.

The silkworm, according to the diary, passed through the five stages in forty days. I have elsewhere given an abstract from one of M. Bonafoux's diaries. The 80,000 silkworms consumed 2887 pounds 6 ounces of leaves, besides a certain quantity of foliage, given in intermediate meals, not herein included. In the last stages, the leaves were given whole. The space occupied in the last stage, is stated in the diary at 607 square feet, but in the recapitulation, it is put down at 3 by 345 feet, which would be something more, or equal to the space in the clear of twenty-three hurdles. Total weight of cocoons, 304 pounds 8 ounces, or 16 to the ounce; all firm, well nourished, sizeable, of a fine straw color. One pound of cocoons has required nine pounds of chopped mulberry leaves.

Let it be again remarked, that this house stands alone, exposed on all its sides to the four winds, and with the ample space above, it might well contain double the number usually allotted in the same area, in buildings covering a wide space, or in situations confined and secluded.

Excess of moisture, being rectified by flame fires, which are sometimes kindled four times a day. Dr. Pascalis, an eminently scientific gentleman, has by electricity inspired the silkworms to hasten their labors. By insulating the hurdles, and by the aid of the electric machine and jar, he has succeeded in bringing their labor to a close in twenty-seven days. He states that he is willing, though it divides the honor of discovery, to appeal to the celebrated Abbe Boissier de Sauvages, who wrote seventy years ago. Sauvages had expressed his belief that the finely pointed appendage or process proceeding from the last ring of the silkworm, was a mysterious organ, the use of which could not be defined, unless it was an *electrical point or tractor*. He proposes to correct the unwholesome condition of a damp atmosphere by fires, which will diffuse a *dry heat:* adding, "That temperature is at all times best for nurseries, in which the air is the most *electrified*, and electrical experiments are the most successful." Rosier, in the *Cours Complet D'Agriculture*, had recommended the use of metallic conductors more than thirty years ago; having himself proved their efficacy. He had found that the silkworms which were contained on shelves which were connected with a cistern of water by thin iron wires were decidedly more healthy and active than those on other shelves which were not thus provided with conductors.

Count Dandolo rectifies the dampness of the air "by burning, in one or two chimneys, shavings or straw, or any small dry brushwood, because the external air thereby attracted, will restore and comfort the languishing worms; and this renewed air by no means can increase the necessary or internal temperature. Another reason why blazing fires are to be preferred, is the quantity of *light disengaged* from dry combustibles; it is surprising how useful this reviving light proves to the insects, and how much it contributes to their health and growth." In more modern times, no fumitory is used,—chloride,

simple chloride of lime, being alone sufficient to purify the atmosphere. Open fire places are now disapproved of in France, other systems being adopted.

SECTION XLIV.

PRODUCTION AND MANUFACTURE OF SILK IN DIFFERENT COUNTRIES.

China, throughout its whole extent, has been famous for its silk from a very remote antiquity. It was there also that sugar was first produced in perfection at a very ancient date. Here, and in its own native forests, was first discovered the silk-worm, whose wonderful works were first rendered useful to man by the labors of empresses and queens. Here during a period of more than 3000 years, its cultivation and education became the lasting resource of wealth to the empire, and the favorite pursuit of man, when in the year 877, a monster appeared in China, and Baichu, a rebel, made himself master of the greater part of the empire. At Canfu, a great city and port, and the resort of the merchant from Arabia and India, he wantonly murdered all the inhabitants, including 120,000 foreign merchants. These consisted of Mahomedans, Jews, Christians, Persees; and not content with the destruction of the human species, this worse than barbarian extended his cruelty to those insects whose chief care had become the favorite pursuit of man, by devoting to indiscriminate destruction every tree of his empire by which the silk-worm was nourished. Thus was utter destruction brought upon the silk trade, during his reign. Canfu and the empire recovered not from the calamities inflicted by this man, until 938, a period of sixty years.

The celebrated Marco Polo, who travelled to the east of Asia, near 700 years since, speaks of "the whole country of China being filled with great, rich, and crowded cities, thronged with manufactures of silk and other merchandize." He has stated, in describing Cambalu, the royal city of China, that "no fewer than 1000 carriages and packhorses, loaded with raw silk, make their daily entry into the city; and silk of various textures are manufactured to an immense amount." Du Halde, also, has stated, that although every year the nations, both of Asia and of Europe, draw from the superabundance of its produce, ships and caravans, laden with vast quantities both of wrought and of unwrought silk, yet still the quantity of plain silks, and those wrought with gold and silver, which remain for consumption throughout the empire are to an incredible amount. To this, also, may be added all the wrought and unwrought silks in immense quantities, which the provinces of China pay as tribute to the emperor.

In modern times, silk is produced in the neighborhood of Nankin, lat. 32°, 32′, even in greater abundance than in any other part of the empire; but the most southern parts are deemed unfavorable to its growth. That country, in all its various latitudes, possesses a climate very nearly resembling our own, it being, like ours, bounded and controlled by an *eastern ocean.*

One principal merit of China silk is its brilliant whiteness. Some suppose that this is owing to some particular process which it undergoes, which is known only to the people of that country.

American merchants are accustomed to sending French patterns to China, which are there imitated to perfection, except being one-fifth lighter, and far cheaper than the fabrics of the French.

The quantities of raw silk which are produced in the territories of the East India Company, are greatly increased since 1766; and the Company now own eight filatures or factories in Bengal—each filature, according

to its size, employing from 3,000 to 10,000 people. But if to these we add the number employed in the mulberry plantations, and in feeding the silk-worms which are connected with each each establishment, they will amount to from 10 to 40,000 men, women and children, to each filature.

To Bengal, filatures and machinery and suitable persons were sent out in 1772, since which time the quality of the silk has progressively improved, and the quantity increased. Bengal silk is called by two names, *country wound,* or that which is reeled in the rude Indian manner, and *filature,* or that which is reeled by the most approved modes of Europe. Again there are the distinctions in the fineness of the thread; also between the fineness of the silk of the filatures of different districts; those of Gonatea and Comercolly being the finest, and next to these are the filatures of Radnagore and Cassimbazar. Most of the raw silk of these filatures, is used in the manufactories of England. From 1770 to 1789, the silk-worms have been successfully introduced from Bengal to Madras, and in 1792 they had become spread in an extent of 600 miles of the coast.

In India the weaver chooses his position beneath a tree, that its foliage may protect him from the rays of a scorching sun, and the cords which sustain his harness are attached to its branches. The loom is of bamboo of the rudest construction. The shuttle is in form of a netting needle, and longer than the breadth of the web; and with this instead of a baton, he beats up the thread of the woof. Yet in this rude mode he is able to prepare a fabric which may vie in beauty with those of Italy.

The Persians for centuries engrossed the whole trade between Rome and China to enormous profit. Their caravans traversed the vast extent of Asia, laden with rich merchandize, from the Chinese ocean to the coast of Syria; the raw silk for the extensive manufactures of Persia, Tyre and Berytus being wholly derived from

this source. The silk of Persia is chiefly produced in the provinces of Ghilan and Shirvan and the city of Schamachia situated near the Caspian Sea. The caravans of Persia travel to Aleppo, to Smyrna, to Scanderoon or Alexandria, and to Constantinople.

The exports of raw silk from Turkey, are principally from the sea-ports of Aleppo, of Tripoli, of Sayda and Smyrna.

In Russia, Peter the Great caused the mulberry plantations to be formed in many parts of his dominions, and these have flourished as far north as lat. 54 deg. Catharine also pursuing the same career, establishments are now in successful operation in Russia for manufacturing silk from native production, and expectations are entertained that Russia will not much longer be dependent on Persia for their supplies of this material. Manufactories of silk are now established at Novogorod, which in many fabrics may vie with those of France.

Even in the inhospitable climate of Sweden, the successful experiment has begun; and by late accounts, the culture of the mulberry tree is extending itself in the provinces, and the most important modes of rearing the silk-worm have, since the year 1823, been generally promulgated: "and the silk so produced in Sweden, has confirmed, in the amplest manner, the remark formerly made on the superior fineness and solidity of silk grown in the north, compared with that of more temperate climates, a fact which has received the unanimous sanction of the members of the Royal Society of Commerce, as well as of many silk manufacturers. It supports the ordinary preparation and dye equally with the best Indian silk, possessing the same brilliancy and softness. Such are the results of the experiments instituted during the year 1823 at Stockholm. The silk also which has been grown for the last two years in Bavaria, is superior to that produced in Italy."

In the island of Sicily, silks are the greatest source of the riches of the country, next to the production of

corn, for which they have long been famous. Their principal factories are at Palermo, at Catania and Messina.

Roger, king of Sicily, after he had finished his crusades to the Holy Land, invaded Greece in 1146. Here he made captive and stole many of the weavers and manufacturers. These he carried and settled at Palermo. These first taught the Sicilians to raise and manufacture silk. Thus the silks of Sicily in twenty years became very famous, being adorned with various colors and figures, and being interwoven with gold and embellished with pearls.

Italy has for many centuries been famous for its silk manufactures and its culture. The silk reel which has served as the foundation or model for others now in use, was first invented and used in Piedmont. And till the beginning of the 16th century, Bologna was the only city in Italy, or indeed in any other country, which possessed throwing mills, or the suitable machinery for twisting and preparing the silken fibres for the weaver.

Such is the great extent of the culture of silk throughout Italy, that according to Count Dandolo, two-thirds of all the exports from that country consist of raw silk or its manufactures. This nobleman examined all the systems and modes of treatment of the silk-worm, with scientific research and diligent care; and not content with disseminating widely by his writings the practical information he had by long experience acquired, he invited the great proprietors, his countrymen, to send pupils to be instructed by him, that thus they might obtain practical instruction on his modes of treatment.

Soon after the publication of the celebrated treatise of Count Dandolo, extensive establishments were formed in Lombardy on the principles and plan which he had recommended. These were called *Dandolières*, as a testimony of honor and respect to disinterested philanthropy.

In Switzerland the extraordinary progress of the silk

manufactures, during a very recent period, has been such as even to cause an alarm to the manufacturers of France. Such has been their success, that now they even annoy by their rivalry the French in the great markets of Frankfort and Leipsic; and such their encouragement, that other Cantons who were only before engaged in the manufacture of fine cottons, are now transferring their labors to silk.

When, in 1810, Napoleon so strictly prohibited the admission of cotton goods into France, the inhabitants around the lake of Zurich transferred their labors, and with signal success, to the manufacture of silk goods. And when with the restoration of the Bourbons, the detestable persecutions for religion commenced; and during 1815, 1816, 1817, great numbers were induced to emigrate from Lyons with their industry and skill, which they carried to Zurich. Thus reinforced, Zurich, which in 1814 contained not more than 2,000 looms, in the beginning of 1828 already numbered from 9,000 to 10,000 looms, with extensive factories.

The mulberry tree was first introduced to France by the French who followed Charles VIII., in his invasion of Italy in 1494, but no considerable results followed till Traucat, a common gardener of Nismes, laid the foundation of a most extensive nursery of white mulberry trees in 1564, from whence the whole southern provinces became covered with plantations. Henry IV. not only bestowed great encouragement and rewards for the cultivation of the mulberry tree, and establishing nurseries, but he naturalized the culture as far north as Orleans, and manufactures of silk were now for the first time established at Paris, and soon became general throughout France.

Even titles of nobility were offered and conferred by this monarch on the first manufacturers, on condition they should sustain them during twelve years. He also planted the mulberry trees near Paris, and introduced the silk-worms at the Tuilleries, and at Fontainbleau, where they appear to have succeeded well.

It is recorded of Colbert, the minister of Louis XIV. that, in his great zeal to increase the production of silk, not content merely with giving away the trees from the nurseries of the Royal Gardens, he even caused them to be transplanted at the expense of the government. But the consequence of this over degree of liberality was the defeat of its own object; and the trees thus easily obtained, were either neglected or wilfully destroyed by the peasantry; and a new plan was adopted, the wisest and most effectual which had ever been devised. Rewards were now offered of three livres to the cultivator of every mulberry tree which should be found in a thrifty and flourishing state three years after being transplanted. Soon the salutary effects of this encouragement appeared, and Provence, Languedoc, Dauphiné, Vivarais, Lyonnois, Gascony, and Saintonge became speedily covered with the trees of the mulberry.

The silk district of France lies on two sides of the Rhone, and includes thirteen departments of the kingdom, [Lyons being the northernmost point.] Although, during the last twenty-five years, the quantity of silk produced in France has exceedingly augmented, yet they still annually import to the amount of 43,000,000 francs, for the supply of their manufactures, from foreign sources.

The culture and manufacture of silk have stood alone, with little protection; they have flourished in France by neglect, because they were suited to the taste of the nation. The curious fabrics, and patterns so unsurpassed, are the result of highly cultivated taste. Their first and best models are the refined imitations of nature. This branch of industry, though least of all protected, has, from this very cause alone, withstood unmoved the utter subversion of all things else.

Lyons is not only the greatest silk manufacturing city of France, but the greatest in the world, for the most elegant fabrics of figured silks, the productions of taste and fancy. In 1812, the city of Lyons employed 10,720

looms, and 15,506 workmen, but in 1824 the silk looms amounted to 24,000, and the number of workmen to 36,000, and in 1825, the number of factories is stated at 8526, and the number of looms within the city, 20,101. The cause of the apparent diminution was the dispersion of the weavers to the villages in the circle of the department, where labor, and consequently provisions, were cheaper than at Lyons.

The following account of the *Jacquard-loom* is extracted from the work of Dr. Ure, on the "*Philosophy of Manufactures.*"

"The history of the introduction of the Jacquard loom is a most instructive lesson on the advantage of free intercourse and rivalship between different countries. The inventor of that beautiful mechanism was originally an obscure straw-hat manufacturer, who had never turned his mind to automatic mechanics, till he had an opportunity, by the peace of Amiens, of seeing in an English newspaper the offer of a reward by our Society of Arts, to any man who should weave a net by machinery. He forthwith roused his dormant faculties, and produced a net by mechanism; but not finding the means of encouragement in the state of his country, he threw it aside for some time, and eventually gave it to a friend, as a matter of little moment. The net, however, got by some means into the hands of the public authorities, and was sent to Paris. After a considerable period, when Jacquard had ceased to think of his invention, the Prefect of the Department sent for him, and said, "You have directed your attention to the making of net machinery." He did not immediately recollect it, but the net being produced, recalled every thing to his mind. On being desired by the Prefect to make the machine which had led to that result, Jacquard asked three weeks' time for the purpose. He then returned with it, and requested the Prefect to strike with his foot on a part of the machine, whereby a mesh was added to the net.

On its being sent to Paris, an order was issued for the arrest of its constructor, by Napoleon, in his usual sudden and arbitrary way. He was placed immediately in charge of a gendarme, and was not allowed to go to his house to provide himself with necessaries for his journey. Arrived in the metropolis, he was placed in the Conservatoire des Arts, and required to make the machine there in the presence of inspectors; an order with which he accordingly complied. On his being presented to Bonaparte and Carnot, the former addressed him with an air of incredulity, in the following coarse language:—"Are you the man who pretends to do what God Almighty cannot do,—to tie a knot in a stretched string?" He then produced the machine, and exhibited its mode of operation. He was afterwards called upon to examine a loom on which from 20,000 to 30,000 francs had been expended for making fabrics for Bonaparte's use. He undertook to do, by a simple mechanism, what had in vain been attempted by a very complicated one: and taking as his pattern a model machine of Vaucanson, he produced the famous Jacquard loom. He returned to his native town, rewarded with a pension of a thousand crowns, but experienced the utmost difficulties to introduce his machine among the silk weavers, and was three times in danger of being assassinated. The Conseil des Prud' Hommes, who are the *official* conservators of the trade of Lyons, broke up his loom in the public place, sold the iron and wood for old materials, and denounced him as an object of universal hatred and ignominy. Nor was it till the French people were beginning to feel the force of foreign competition, that they had recourse to this admirable aid of their countryman; since which time they have found it to be the only real protection and prop of their trade."

In the invention and formation of the most elegant figured patterns, as in most other branches of the fine arts, the taste of the French is superior to that of the whole world; their patterns being the imitations of

nature itself. Even every common weaver makes it his study to produce them; the botanist and the florist forms his patterns by an imitation of the various combinations which he is enabled to produce from the flowers which he gathers in the gardens or fields. To this it must be added, that, in every considerable establishment, there are one or more artists or painters, which are selected from the pupils of the schools which are expressly established at Lyons or other places for their instruction. These have a fixed salary, varying from 1,000 francs to 2,000 francs per annum. These drawings are transferred to cards or cartoons—and these cartoons are punched with holes to receive certain wires, and the card pattern, being completed, is adjusted to the Jacquard loom. The movements of the machine are self-adjusted, and regulated by these pattern cards, and the most perfect and beautiful figured silks are woven without the aid of any particular skill, and by any common weaver. For shawls of great beauty and variety, the expense of new mounting a pattern for the Jacquard loom, may amount to 1,000 francs, or about $184.

In England, acording to Dr. Ure, from 100 to 4,000 cards may be required for a pattern in a Jacquard loom. With one containing 816 cards, the cost of the draft, writing and stamping, will amount to £10 or $44 44, and the annual expense for change of patterns for the Jacquard looms, to the English manufacturer, is stated to be about £12 each, or $53 33. The total cost of a Jacquard loom in England, varies from £15 to £30, or from $66 66 to $133 33.

According to a very late report on the silk manufactures of France, they were never in a more flourishing state than at present. France has now in full operation 70,000 looms for silk; each of these looms weave annually sixty pounds of silk on the average of the whole.

The consumption and demand for ribbons are stated to be enormous. The splendid Cashmere shawls are now so successfully imitated in France, that these imitations command a price in proportion to their quality, of from a dollar and a third, to four hundred and forty-four dollars each.

From the report of the investigations on the Silk and Wine trade of France, which were lately made by Dr. Bowring to the British parliament, it appears, that the total amount of silk manufactures exported from France was to the value of $25,000,000 in 1832. "Of this amount, nearly one half is of plain silks, of which the United States take one third, and in some years nearly one half of the whole export." Of figured silks, and other silk articles, the United States are also the largest purchasers; and it has been deemed an assertion perfectly safe on the side of truth, that France exports annually to the United States alone, ten millions of dollars worth of silk. Much also is imported into America from Switzerland.

England, from its variable climate, and its humid and clouded atmosphere, is found unsuited to the growth of silk, as has been proved in their successive attempts in 1620, 1629, 1718, and again in England and Ireland in 1823, all which have failed from the above causes. But latterly this same Company have commenced with the pomise of great success at Malta. The cultivation of cotton, which had till very lately been pursued at Malta, having been checked by the increasing production of Egypt, the numerous population of the island were reduced to distress. This new enterprise was hailed with enthusiasm by the Maltese, as a new and profitable source of industry. The growth of the mulberry is more rapid at Malta by full one-third part than it is in Italy. Latterly, also, the English have introduced the

silk-worms to St. Helena. I have before alluded to its introduction by the English to the Island of Mauritius in 1815, and that Mr. Chazal in 1817 had produced 200 pounds of raw silk, for which he received from the Society for the encouragement of arts, their large gold medal, which was offered for the growth of silk in the British dominions. The silk which was grown in that hot climate, and which was carefully examined by some of the most distinguished brokers in London, was stated to be of "tolerable good quality."

The manufactures of England, according to Dr. Ure, were never in a more flourishing state than at the present day. England now imports more than 2000 tons of raw silk for the supply of its manufactures. More than one-third of this comes from Bengal—six hundred thousand pounds from China, half as much from Turkey, Aleppo, Tripoli, Sayda, Smyrna: the rest chiefly from Italy.

The greatest part of the Italian raw silk, which the English manufacturers require, is received from the French, by whom it is smuggled from Italy through the territory of France, it being the absurd policy of some of the Italian States to prohibit the exportation of raw silk. A less proportion is also imported direct from Italy from the states of Leghorn, Genoa and Nice.

The complete establishment of the silk manufactures in England took place in 1685, on the revocation of the edict of Nantes, when the Protestants or Hugonots were driven by religious persecution from France. These settled in England, where they commenced and established the silk manufacture. Yet during the years, and especially the period from 1773 to 1824, and while the silk trade was burthened with restrictions and heavy imposts and prohibitions on the fabrics of other nations, the manufactures of the English languished: nursed and nourished by monopoly, and relying not on itself for support, it became enervated. The smuggler, more than any other class, became enriched by the system,

until, in 1826, Mr. Huskisson, the wise and sagacious minister, demolished the barriers which were raised for its protection, and at once dissolved the charm. The duties on the raw silk, inasmuch as it could never be produced in England, were abolished, and the duties on imports of manufactured silks were reduced to 30 per cent. From that period, the manufactures of England, thus left to rely on themselves, have acquired new energy; and in the healthful but desperate struggle of competition, it has wonderfully augmented its strength. And with the industry and talent, and ready invention of the people, and the introduction of the Jacquard loom of France, and of every species of improvement from abroad, they are now enabled to rival in excellence even the most beautiful fabrics of China, of Italy, of Switzerland, and of France.

Formerly, the silk manufactures of England were chiefly confined to Spitalfields; but now, in a great measure, Manchester has become the emporium. The throwing-mills of that place, in 1832, required for their movement a power of steam equal to 342 horses. In 1819, there were not fifty silk looms in Manchester, and now there are 12,000 looms, whereof one-third are for silk with admixture, and two-thirds for silk alone. Power looms for silk are believed to be but little used in England;—they are an invention of but a few years, the weavers of the old school being opposed to their introduction. Thus it was in England on the first invention of the power looms for cotton, their introduction being opposed by mobs, and the wonderful machines consigned to destruction, and their authors to execration.

I have stated that the silks left for consumption in Great Britain alone, so late as 1835, amounted to the enormous sum of $28,282,582 annually, at the wholesale prices, besides the whole amount of all they exported.

SECTION XLV.

CLIMATE OF AMERICA; SILK ESTABLISHMENTS, &c.

THE amount of silk which is imported into the United States, and left for annual consumption, has at this day become very great. The fabrics of silk, so surpassing, will take the precedence of others, so far as they excel them all in delicacy and in softness, in eminent beauty and in strength, and the demand and consumption of silk will go on, and that continually, augmenting more and more.

The silk of America is found to contain a fibre, stronger, and of a quality superior to that of almost any other country. This appears to be a point which has been established by incontrovertible evidence. Specimens have been examined by the Chamber of Commerce at Lyons, at a very late date. Other intelligent Frenchmen, both here and in that country, had before examined and compared, and attested to the truth of this important fact.

The causes of this superiority may be traced either to soil, or what is more probable, to our fine and serene climate during summer.

The climate of America, on the side of the Atlantic, is more constant and invariable in the States of the North, than in those of the South. In those of the North, the destructive vernal frosts are unknown, or but of rare occurrence: for in these States the frozen earth is for the most part protected during winter at the freezing point by the usual covering of snow; this covering is preserved from dissolution by the piercing cold winds of the north. During our winters so intensely cold, and so fortunately prolonged, vegetation slumbers, nor awakes till the summer has come, and the danger is past. During winter, the silk-worms exists but in embryo, and

unconscious of all things; they have only to do with our summers.

The temperature of the air, and the general state of the atmosphere, as I have elsewhere stated, have a powerful effect on the filature and the spinning of silk; both are favorable in Piedmont. Italy is renowned for its delightful climate and serene atmosphere. I will now attempt to shew that our own climate, during summer, is more favorable to the silk-worm than that of Europe, in the proportion of two to one. The average heat of our midsummer months must be nearly equal to that of Rome, in Italy, and of Marseilles, in the south of France; since *the mean of the greatest heat* at Cambridge, which is in lat. 42 deg. 23 min., exceeds that of Rome by 11 deg., and that of Marseilles by 8 deg. The mean of our greatest summer heat being 97 deg. and seldom a summer passes that the thermometer does not rise to 100 deg. or more.

From the average of the observations which have been made in twenty cities on the continent of Europe, I shall compare the climate of America.

While the quantity of rain which annually falls in the twenty cities of Europe is but thirty inches, with us it is fifty inches: yet in Europe, while it rains annually 122 days, we have but eighty-five or ninety days of rain; the rain with us descending, not in slow and perpetual showers, but more often in profuse showers and in torrents. Yet while in the twenty cities of Europe the number of fair days or days of sunshine is but sixty-four in the year, in America we have annually 130 bright days, or days of sunshine, or a double number which they have in Europe. Thus it evidently appears that during summer, the climate of the finest countries of Europe can by no means compare with ours—with our skies so serene, our atmosphere so unclouded, with our days of brilliant light and more perpetual sunshine. During the cold days which may sometimes occur, there is always the easy remedy; but in excessive and long continued

heat, there is no remedy but to open wide every door and window. The sirocco of some parts of Italy is peculiarly unfavorable, and at times utterly destructive.

According to the letters of Messrs. Spaulding and another missionary, who so lately travelled with their wives over the Rocky Mountains, and to the mouth of the Columbia, we have in that region a climate the most mild, equable and temperate on earth, and corresponding with the most favored countries of the south of Europe, of Portugal, and of Spain. They make mention of one rich farmer near the mouth of that river, having hundreds of horses, and many hundreds of cattle and swine, which there roam at large, requiring no protection, and finding abundance of pasture at all seasons. In his extensive gardens, they found the orange and lemon trees, and the fig tree, flourishing luxuriantly in open culture, in the latitude of 45 deg.—the latitude of Michigan and of Maine! This vast region must also prove eminently adapted to the culture of the mulberry and of silk. Still later travellers have assured us that a gap has recently been discovered through the Rocky Mountains, twenty miles in width, and the practicability of constructing a railroad from the navigable waters of the river Missouri, to those of the Columbia, and through the centre of our vast national domain, seems now established beyond a doubt. Thus will that delightful region, which promises to become one day the Eden of our country, and those our distant and lone settlements, bounding and immediately contiguous as they are, to those of the aspiring autocrat of Russia, be brought nigh, even under the wing and immediate protection of our country and the great Republic. Such a project is indeed not in advance, *but only commensurate*, with the onward march, and wonderful movements of the age in which we live. Circumstances may, and will arise, at some future, but not very distant day, which will arrest the attention of the enlightened patriots and statesmen of our country, and awaken them to its

consideration, as to a subject of vital interest and importance.

The culture of silk was introduced into America at a very early date. James I. of England, more than two hundred years ago, not only sent over to Virginia the mulberry trees and the silk-worms, but he also composed a book of instruction on its culture, and endeavored by every mode to encourage its growth, as much as he hated and endeavored to discourage the growth and use of tobacco. Aided by the encouragement thus afforded, and by legislative enactments, the cultivation of silk flourished for a time both there and in Georgia, even when opposed to the lucrative culture of tobacco, of rice, and of indigo, these last being annual productions, and yielding a profit both sudden and more immediate: and a king and a queen, and of England too, might well be proud of the garments of silk which they once wore—these being the productions of their own colonial country, even of America. One day they may wear them again.

In other States, too, the silk culture was making hopeful progress; and at Philadelphia, Dr. Franklin had already established a filature, when the war of the revolution commenced.

For seventy years the raising of silk has been the regular profitable employment of many of the farmers of Connecticut during the early part of the summer. Theirs, however, seems to have been a primitive system, not altogether perhaps unlike the system which was practised in China 4000 years ago. The common reel, and common spinning wheel and loom, constituted the chief amount of the machinery which was known to them, until very lately; the silk-worms being fed in dwelling houses, or sheds, or barns, no fires being afforded to them at at any time, nor indeed was it ever supposed to be needed by them in that favored climate.

The introduction of the wonderful machines for spinning wool and cotton, and the *power looms*, which are

now moved by water, or by wonderworking steam, have put an end to these last branches of domestic industry, and cotton having in consequence almost entirely superseded the use of hemp and flax in domestic use, in the abodes of our countrymen, the sounds of the loom, the distaff, and the spinning wheel, are no longer heard.

Even machines for knitting are now constructed. I have seen them and witnessed their operations. They were lately invented by a Pennsylvania farmer; they work to wonderful perfection, and to immense saving of labor and of time, and will soon make an entire change in this remaining branch of domestic manufactures.

The reeling of silk in France and Italy, is performed almost exclusively by females. In these countries there are innumerable *domestic* filatures, where the cocoons raised by one or more families are reeled by the wives and daughters of the farmers. These employ from one to five or six reels, and the art of reeling is preserved in families, from generation to generation. There are, also, in these countries, large establishments, or filatures, which employ from fifty to five hundred reels; these establishments have a superintendent, who is thoroughly and practically a perfect master of the business in every department. Women there are here, who work at the reeling all their days as an exclusive occupation.

At these large establishments, the most perfect silk is reeled, and that which commands the highest price.

At the establishment of the Harmony Society, at Economy, in Pennsylvania, on the Ohio river, silk is cultivated and some figured silk vestings have been produced, which may vie with the most beautiful fabrics of Europe. The celebrated Mr. Rapp, who is the patriarch of this establishment, hesitates not to affirm that the raising of silk is as easy as the raising of wheat, and much less laborious.

At Lisbon, and at Mansfield in Connecticut, there are new manufactories of silk, and many foreign workmen are there employed.

At Poughkeepsie in New York, a large establishment has recently commenced operations.

At Northampton, a large establishment for the manufacture of silk has gone into successful operation under the superintendence of Mr. Whitmarsh.

At Dedham, Mass., a new manufacturing company and establishment has lately been formed, which has been placed under the superintendence of Jonathan H. Cobb, Esq., who is well known as a gentleman of experience, and eminently distinguished for his zealous exertions in the cause of American manufactures, and particularly those of silk. He is the well known author of the "Manual on the Mulberry Tree and the Culture of silk." This establishment is extensive, and manufactures sewing silk of the first quality, and other fabrics on a large scale.

Messrs. Montague's establishment is situated in Washington street, in Boston, and has been in successful operation for about four years; about three hundred females being constantly employed. Here are from one hundred and fifty to two hundred looms for weaving Tuscan braid. These braids are formed of a great variety of elegant patterns; the silk constitutes the warp, but the filling is formed chiefly of the imported Tuscan straw, with a mixture occasionally of the Manilla grass, which is the same material which is used in the formation of the grass ropes; this substance being of a white color, and shining appearance, contributes to form an elegant article; with this is also occasionally mixed, thin fine strips of whalebone, of a white color and shining.

They here manufacture eight hundred bonnets a week, or from eight to twelve hundred, of a great variety of elegant forms and patterns; all of which find a ready and profitable sale both in the North and at the South and West. These usually sell by the wholesale, from $2 50 to $4 each; some, however, for children are sold as low as $2 each.

Much gimp is here manufactured, and used in the structure of bonnets. A thread having been prepared by being wound around and completely covered with silk, a coarse cotton cord twenty yards in length is next attached to a swivel, and the other end to a spindle. This cord is made to revolve with astonishing speed, and the fine prepared cord, which a workman carries at a good walk, is speedily wound round it as a covering, the whole having the appearance of silk. This thread or finer cord is first wound round with the silk in the same manner. The simplicity of this machinery, the wonderful rapidity of its execution, are calculated to strike the beholder with surprise and admiration.

Here also is a *ribbon loom*, which weaves a dozen ribbons at a time. This is furnished with a dozen spring shuttles, which are put in motion by a single hand at the same instant of time.

Here is also another loom for galloon, which weaves twenty pieces at a time, moving twenty shuttles at once, by a single hand.

The quantity of silk which is consumed in this establishment, is from thirty to fifty pounds in a week. A part of this silk is imported direct from China; and a part is bought in England at the London docks, and before it becomes liable to a duty at that place. It is imported into London by the ships from India and China. But some of the finest silk which is used in this establishment has been imported from France, as I am informed, at a cost of $11 per pound. There is also in this establishment a throwing mill for making organzine and tram.

Other establishments for manufacturing are also arising in various sections of the country, but the great and all-important work which is now in successful progress throughout the country, is the preliminary enterprise of raising the silk.

SECTION XLVI.

DUTIES ON SILK AND PROTECTIVE LAWS.

It has been, at times, the policy of the American government, to impose duties on certain raw materials for their production at home, as well as for the purposes of revenue. Such has been the case with bar and unwrought iron, and wool, indigo, tobacco, cotton and sugar; this last, being an article whose culture is local, its consumption as an article of food, and one of the most wholesome sweets in nature, has become very great, and it is now considered as one of the necessaries of life. Yet, in the view of that equal encouragement which is justly due to the poor, who purchase all for their consumption, and to the manufacturer, it will be deemed expedient that the duties on the raw material should be rather light.

Even on wrought silks, whose manufacture we all should be desirous to encourage, the duties imposed, whether for this, or for the purposes of revenue, should be but moderate. Prohibitory laws will be but of little avail. Competition, though restrained, yet inasmuch as it gives new life and energy, its vivifying influence must not be extinguished. As in the case of all other manufactures which are now so eminently prosperous, we fear not the conflict; resolved to conquer, in the struggle with competitors, we shall acquire new powers, and wonderfully improve our strength, till we come off victorious.

In England and in France, where the silk manufactures now flourish beyond those of any other country, they have, by experience, found that a very moderate duty on the imports, is in fact the only true policy. This duty on manufactured silks in France at the present day is but from fifteen to seventeen per cent. But in

England, since 1826, it is reduced so low as thirty per cent.

Manufactured silks, from their very great value in proportion to their bulk and weight, like silver and gold, will not bear a heavy duty on imports. Burthensome duties and imposts on silk may oppress, while they serve but to enrich the smuggler, who seizes both the commerce and revenues of the country as his own, for the double character which he assumes.

In England, under the former system of monopoly and exclusion, it had never been found possible to stop the prosecution of the contraband trade in silk goods. And to such a perfect system had this illegal trade arrived, that silk goods, of any and every description, might be purchased in France, with the guarantee of the seller, that they should be safely delivered at the very house of the purchaser; the amount thus put to hazard being again insured at offices established for that purpose in France, where legal policies of insurance were to be obtained against seizure, with the same facility as for protection against the dangers of the seas, or of fire. These premiums varied in proportion to the degree of danger which occurred, from the vigilance of the officers of the revenue. Of the amount thus smuggled from the kingdom, no notice or report is ever entered in the custom houses of France.

According to the statements of one of the presidents of the board of trade, the Right Honorable Vesey Fitzgerald, which was made before the House of Commons in 1829, and on the authority of French merchants, the total cost per cent. on the value for smuggling *and insuring* silk goods from France into England, was as follows: on Gros de Naples 28 to 29 per cent.; on Satin Ribbons 24 to 25 per cent.; on Sarsnet Ribbons 25 to 26 per cent.; on figured Gauze 28 to 29 per cent.; on Blonde 12 to 13 per cent. The rates of insurance on the latter article being less, so much as its value is greater than that of other articles in proportion to its

bulk, thus rendering the work to be accomplished by the smuggler more easy.

The amount of goods, of the most light and costly fabrics, which are smuggled into France by dogs, from the boundaries on the side of Germany and Italy, is estimated at many millions annually. These dogs are strong and powerful, and trained in bands for the purpose. Their loads being adjusted near the frontiers, they start by night in strong droves, and always depart hungry: having passed the frontiers by routes best known to themselves, they arrive at the houses especially prepared for their reception on the side of France, which await to receive them; their journey being ended, they are rewarded for their labors by receiving their wonted and bountiful supplies of food.

SECTION XLVII.

ECONOMICAL MODES OF HEATING.

One of the most economical modes of applying heat, either for warming hot houses or any other apartments, consists in the immediate application of steam to large masses of small, round, loose stones, such stones as serve no other purpose than to encumber our fields and highways. The mass thus heated will retain its warmth for a long time, giving it out slowly. Every person knows that even a single brick, if properly warmed, will retain its heat for a long time. This mode appears to have been first adopted at Edinburgh, in Scotland, in 1807, and is described in the Memoirs of the Caledonian Horticultural Society, and also in the Transactions of the Horticultural Society of London, and also in Loudon's Mag., vol. x. p. 226. The first uses to which this new system was applied was for the

purpose of heating hot houses. For this purpose timbers should be laid on the ground, and on these planks are placed, the whole a little descending, that the water of condensation may drain off. On all sides it may be enclosed by masonry of brick or stone, laid in suitable mortar. The steam pipe is laid four inches above the platform; and over this, the whole area is filled to the depth of three feet, with round stones, from three to six inches in diameter; on this smaller stones, gravel, sand, and finally loam, may be placed, and the soil and structure are prepared for cultivation. The steam pipe may be of any dimensions, the only difference is that in a small tube or iron pipe, the steam issues with greater force. The usual dimensions of the steam pipe, as named, may be an inch in diameter. It contains perforations of one-tenth of an inch in diameter, for the emission of the steam. These holes are eighteen inches asunder at the end next the boiler, but diminish in distance, an inch to every sixteen feet, till they reach the extreme end, which is closed. The heat is thus distributed uniformly from end to end. Generally the direction of these holes is upwards, but some few are in the bottom to drain off the condensed water.

The steam requires to be admitted from the boiler once in twenty-four hours, in the most severe weather, and but once in two or three days in moderate weather; and then an hour or two is sufficient, or as soon as the steam escapes from the safety valve, as this shews that the stones have become so far heated that they will no longer condense the steam.

This system requires no night work. The mass of stones being insulated and enclosed, will retain its heat in proportion to the dimensions of the mass, and for a longer or shorter space of time.

Cases of brick or stone masonry to serve as flues, and filled with rubble stones, or pieces of brick, or round stones, may be built around the sides, or within the area of the apartments, which may thus be warmed

for any required purpose; or these flues may be enclosed in others of wood, leaving space between, for the purpose of warming by currents of heated air. These reservoirs, or manufactories, for heated air, may serve by means of flues for warming our own apartments in winter. In early spring, other flues may be connected for the purpose of warming the green house, or house for early vegetables, and during cold days and nights in summer, when needful, the same economical apparatus may warm the *magnanèries* for the silk-worms, inspiring them with new life.

In some private families in the vicinity of Boston, as well as in some large public establishments, almost the whole process of cooking is performed by steam, and in vessels remote from the boiler, with important saving of time, and of labor.

SECTION XLVIII.

PRICE OF LABOR, POWER OF AUTOMATA OR MACHINERY.

At page 120, I have shown on high authority, and endeavored to demonstrate by conclusive evidence, and many important facts, that in those countries where labor is dearest, more ingenuity, more talent, skill and industry are brought into action, and that those countries are thus enabled, almost invariably, to undersell other nations where labor is cheap. Thus, in ships and in navigation, who can compete with the free maritime states of America, and especially those of New England? Do they not navigate their ships cheaper and with greater economy than any other nation, in every sea?—and yet in no great maritime country on earth are the nominal wages of seamen so dear.

Thus I have also stated at page 121, that while the throwsters of France and of Italy are still content if their spindles do but revolve from 300 to 400 times in a minute, those of the English, where labor is dearer than in any part of the continent, are now performing from 2000 to 3000; but by a late improvement of Mr. Ritson, they are now made to perform 4500 revolutions in a minute; yet the spindles for cotton, which are put in operation by our own countryman, Mr. Pettee, of Newton, Mass., actually perform about 5000 revolutions, or revolve at the inconceivable speed of eighty rotations in a second of time.

At the silk establishment of Mr. Cobb, at Dedham, Mass., we have witnessed a boy of 13 years of age, attending one hundred spindles; thus performing, as we were reminded by Mr. Cobb, the same amount of labor which in China is allotted to a hundred laborers.

For the following very important facts in relation to the surprising progress of the cotton manufactures of our own country, I am indebted to the kindness of Dr. Hobbs, who is the agent of the great establishment of the Boston Manufacturing Company at Waltham. It is an extract from a letter received from him, dated Oct. 29th, 1836.

"When the Boston Manufacturing Company established their works at Waltham, there were no power looms in use in this country, and the yarn spun for the first year or two, was sent to private families to be woven. The price paid for weaving a yard of 37½ inch cloth, of No. 14 yarn, varied from eight to twelve cents a yard—a price fully equal to that which has been obtained for the cloth, on an average, for the last five years. Since the power loom has been in operation, it has been continually undergoing improvements in all its parts—particularly in the reeds, harnesses, and shuttles. The price paid for the weaving has varied with the facilities afforded for turning off the cloth. At first, the looms were driven after the rate of from seventy to

eighty beats per minute, and the quantity woven in twelve hours was from twenty-five to thirty yards. We then paid one cent per yard for weaving. The looms now go after the rate of from 120 to 130 beats per minute, and each loom turns off from forty to forty-five yards of cloth in twelve hours. We now pay three-fifths of a cent per yard for the weaving;—each girl has two looms, but occasionally tends three. For weaving of finer numbers, a higher price is of course paid, as a less quantity of cloth is woven with the looms at the same speed."

"The improvements in the spinning of cotton yarn by water power, are perhaps more striking than in the weaving department. A girl attends to 256 spindles, which will spin 1,300,000 yards, (or about 740 miles in extent,) of No. 14 yarn, in twelve hours, which is equal to 1548 hanks, or 110 pounds. To do this on hand machines twenty years ago, in twelve hours, would have required upwards of 500 girls."

Thus has America been enabled to compete with India and with China, and even with the world, in the culture and manufacture of cotton, and also to undersell them even in their own markets. Is there one American who can doubt that we shall do the same, ere long, in regard to silk.

SECTION XLIX.

REMARKS ON THE CLIMATE OF THE NORTHERN STATES.

The valleys of our great northern rivers or arteries, possess a climate, which, at certain seasons during winter, is not elsewhere to be found in corresponding latitudes, and which has been by some compared to that of Siberia. These vallies, however rich and fertile, are

exposed alike to the destructive frosts of winter and of summer. The winds which blow almost invariably in the longitudinal direction of these vallies, bring down at certain seasons, a degree of cold the most pernicious and destructive. Not only, in certain cases, have all manner of fruit and mulberry trees been destroyed, but also the button wood, the red cedar, and the oak. At Troy, and at Albany, both downwards towards the Cattskill, as well as upwards towards Champlain, we have the records of a degree of cold the most extraordinary. Throughout these extensive vallies, and great northern floodgates, the rigors of a Canadian winter are precipitated—of winters intensely cold, brought down by winds from high northern latitudes and the frozen regions of the arctic circle.

Thus also in the valley of the Nashua and at Lancaster, in Massachusetts, Mr. Breck has observed the thermometer to descend as low as 33 deg. below zero. At Northampton, also, in Massachusetts, in the valley of the Connecticut river, the thermometer has at times been observed to descend to 33 deg. below zero. Also at Greenfield, on this same river, and about the latitude of 42 deg. 40 min., as the Rev. Henry Colman has informed me, he once observed that the mercury of his thermometer had descended quite into the bulb, and more than to 37 deg. below zero, which was the lowest point marked on the scale of his thermometer. At other points, the mercury has been observed to descend to 38 deg., and even to 44 deg. below zero.

THE SILK-WORM'S WILL.

BY MISS H. F. GOULD.

On a plain rush hurdle a silk-worm lay,
When a proud young princess came that way.
The haughty child of a human king
Threw a sidelong glance at the humble thing,
That took with a humble gratitude
From the mulberry-leaf her simple food—
And shrunk, half scorn and half disgust,
Away from her sister child of dust;
Declaring she never yet could see
Why a reptile form like this should be—
That she was not made with nerves so firm,
As calmly to stand by a "crawling worm!"

With mute forbearance the silk-worm took
The taunting words and the spurning look;
Alike a stranger to self and pride,
She'd no disquiet from aught beside,
And lived of a meekness and peace possessed,
Which these debar from the human breast.
She only wished, for the harsh abuse,
To find some way to become of use
To the haughty daughter of lordly man,
And thus did she lay a noble plan,
To teach her wisdom and make it plain
That the humble worm was not made in vain;
A plan so generous deep and high,
That to carry it out she must even die!

"No more," said she, "will I drink or eat!
I'll spin and weave me a winding-sheet,
To wrap me up from the sun's clear light,
To hide my form from her wounded sight.
In secret then till my end draws nigh,
I'll toil for her; and when I die,

I'll leave behind, as a farewell boon,
To the proud young princess, my whole cocoon,
To be reeled and wove to a shining lace,
And hung in a veil o'er her scornful face!
And when she can calmly draw her breath
Through the very threads that have caused my death;
When she finds at length she has nerves so firm
As to wear the shroud of the crawling worm,
May she bear in mind that she walks with pride
In the winding-sheet where the silk-worm died!"

LIST OF AUTHORS AND PUBLICATIONS WHICH HAVE BEEN QUOTED OR CONSULTED.

NAMES of the authors or authorities which are sometimes either quoted or referred to in this work.

Much valuable information is contained in the Treatise of Dr. Pascalis of New York on the Mulberry Tree and the Culture of Silk; also in his Silk Culturist formerly published in New York.

The "Manual of the Mulberry Tree and the Culture of Silk," of Mr. Cobb, is well known. It was drawn up by him, by order of his Excellency the Governor, and the Legislature of the Commonwealth of Massachusetts.

I have often had occasion to refer to the Comte Dandolo and M. Bonafoux, of Piedmont, and their works. These are the great Italian masters, and expounders of the modern system of Italy. The work sent by the Comte de Hazzi of Bavaria, and transmitted through Dr. Mease to Congress, was chiefly composed from these Italian masters, the Comte de Hazzi being professedly their disciple. We are also much indebted to the writings and publications of Mr. Rush, while Secretary of the Treasury. Much is also ascribed to the writings and Essays of M. D'Homergue, a Frenchman of Nismes in France, and master in the art of the filature, who is now at Philadelphia. Much also is due to the venerable Duponceau and numerous others who have written largely on the subject.

"Summary of the Principal Chinese Treatises on the Culture of the Mulberry, and the Rearing of Silk-worms." Translated from the Chinese into French by Stanislaus Julien. Transmitted from Paris to the Secretary of State, and rendered into English by Peter Force, Esq., Mayor of the city of Washington.

Chinese Volume of Splendid Descriptive colored Engravings in Quarto, representing the Chinese Process of Cultivation and of raising Silk.

Cours Complet D'Agriculture, a most complete work, published at Paris.

Annales de L'Institut Royal Horticole de Fromont by the Chevalier Soulange Bodin, in 6 vols. from 1830 to 1835. Paris.

A Treatise on the Origin, Progressive Improvement, and Present State of the Silk Manufacture. By Dr. Lardner. A most valuable and late work.

Philosophy of Manufactures. By Dr. Ure. London, 1835. A most invaluable work.

Silk Manual compiled and written by Edward P. Roberts, Editor, Farmer and Gardener. Baltimore, 1835. A valuable work.

A Valuable Manual on Silk, by Judge Comstock; Hartford, Conn. 1836.

Also the Silk Culturist, a valuable periodical by the same writer.

The Silk Worm, a valuable periodical edited by S. Blydenburg of Albany.

The Silk Manual, another excellent periodical, edited by the late Thomas Green Fessenden of Boston.

The American Silk Grower is another valuable periodical, edited by Messrs. Cheney, of Burlington, N. J.

Gideon B. Smith, Esq., formerly the editor of the American Farmer, printed at Baltimore, has done much in aid of the cause by his writings in that periodical, and also by a manual he has published.

Jonathan H. Cobb, Esq., of Dedham has also rendered very important services to the cause by his valuable Manual on Silk, the lectures he has given on the subject, and his successful practice in its manufacture. To these names I will add, that posterity will be indebted also to the efforts of Dr. Franklin, of Aspinwall, of Pinkney, and of the Rev. President Styles at an earlier period of time.

Other and very numerous writers there are, of the present day, which we need not name.

Much is due to the unwearied labors of the Hon. H. A. S. Dearborn for his luminous writings. His important services in the cause of the science of Horticulture, also of Silk, have given a powerful impulse, which will be felt and acknowledged both by the present and future generations.

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